



Fig. 1. Digital flexor tendon sheaths.

(A and B) Contrast medium within the synovial sheath (arrows) extends from a site close to the distal interphalangeal joint to one proximal to the metacarpophalangeal joint. No communication with the palmar synovial sacs is seen.

extensor tendon sheaths on the dorsum of the wrist was accomplished. The tendons can be easily palpated and a needle inserted through the dorsal carpal ligament.

# THE DIGITAL FLEXOR TENDON SHEATHS (Fig. 1)

The flexor tendons of the fingers, the sublimus digitorum and profundus digitorum, are enveloped by digital sheaths from a line of insertion of the flexor profundus to a line I cm. proximal to the proximal border of the deep transverse ligament.6 This arrangement, which is not constant, is most frequent in the index, middle and ring fingers. 6,7 Any of these three sheaths may extend to the wrist.10 The flexor sheath of the thumb extends from the terminal phalanx to a point 2-3 cm. proximal to the proximal volar crease of the wrist, although on occasion a septum separates proximal and distal halves of the sheath.7 The synovial sheath of the little finger also commences at its terminal phalanx. It may end near the deep transverse ligament or continue into the palm, expanding to envelop the adjacent tendons

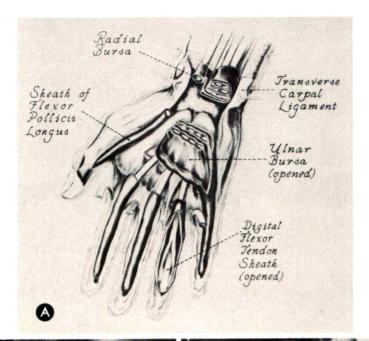
of the second, third and fourth fingers. 5-7

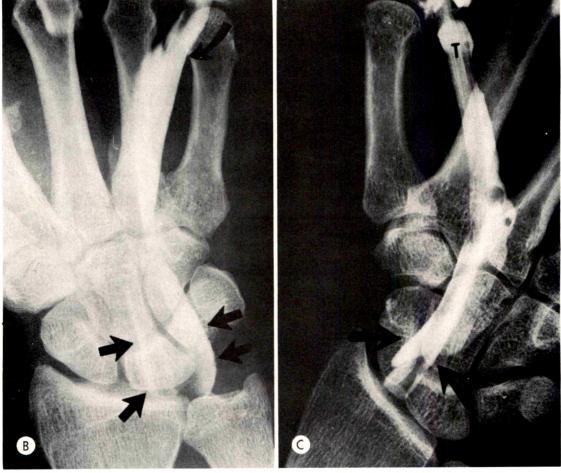
The relationship of the digital flexor tendon sheaths and the joints of the second, third, fourth and fifth fingers is of clinical importance. There is a considerable amount of fibrous tissue between the metacarpophalangeal joint of each of these fingers and the sheath.5 Slightly more distally near the base of the proximal phalanx, the sheath and bone are more intimate; at the proximal interphalangeal joint more fibrous tissue separates the sheath and synovial cavity as at the metacarpophalangeal joint. 5 Sections reveal that the axial portion of the joint capsule at the proximal interphalangeal joint is indistinguishable from the fibrous tendon sheath.4

The digital sheath of the thumb lies distally near the proximal phalanx, but as it ascends toward the palm it separates from the metacarpal head. Thus the sheath is separated from the first metacarpophalangeal joint by considerable fibrous tissue.<sup>5</sup>

## SYNOVIAL SACS OF THE PALM (Fig. 2 and 3)

Communication between the individual





digital tendon sheaths and synovial sacs or bursae in the palm is not constant;<sup>10</sup> most frequently such continuation is noted involving the first digit. Not uncommonly the digital sheath of the fifth finger also continues into the palm.<sup>1,5,7</sup> Such communication is uncommon in the second, third and fourth fingers.

The ulnar bursa on the medial aspect of the palm is composed of three communicating invaginations; 6,7 a superficial extension lies in front of the flexor sublimis, a middle one between the tendons of the sublimis and the profundus and a deep extension is found behind the flexor profundus. 5,6 The bursa, beginning at the proximal end of the finger sheaths, spreads out proximally overlying the third, fourth and fifth metacarpals. A statistical analysis of the tendon sheath patterns in the hand using air insufflation techniques<sup>10</sup> in 367 cases demonstrated that the ulnar bursa communicated with the sheaths of the little finger in 81 per cent, index finger in 5.1 per cent, middle finger in 4.0 per cent and ring finger in 3.5 per cent of cases.

The radial bursa is the expanded proximal continuation of the digital sheath of the flexor pollicis longus. It is found on the radial aspect of the palm overlying the second metacarpal. It continues proximally along the volar radial aspect of the wrist, terminating about one inch above the

transverse carpal ligament.5

Intercommunications between the ulnar and radial bursae are frequent<sup>5,7</sup> and may be noted in 50 per cent of cases.<sup>5</sup> Such connection is made via intermediate bursae. These accessory synovial sacs may be pos-

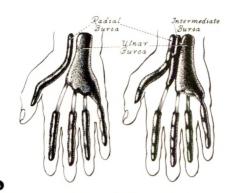




Fig. 3. Palmar sac communications. (A) The radial and ulnar bursae may be separate distinct cavities or communicate via intermediate bursae. (B) The digital flexor sheaths of the first and fifth fingers (T) extend into the wrist. A large palmar sac (closed arrows) consists of communicating radial and ulnar bursae. An intermediate bursa (open arrows) is recognizable.

terior between the carpal canal and flexor profundus of the index finger or less constantly anterior between the superficial

Fig. 2. Synovial sacs of the palm.

<sup>(</sup>A) The digital flexor tendon sheaths of the second through fourth fingers terminate proximal to the metacarpophalangeal joint. That of the fifth finger communicates with the ulnar bursa. The sheath of the flexor pollicis longus is continuous with the radial bursa. Note the 3 invaginations of the ulnar bursa and, in this drawing, absence of communication between radial and ulnar bursae. (B) Injection of the digital sheath of the fifth finger (curved arrow) reveals communication with the ulnar bursa (straight arrows). (C) The synovial sheath of the flexor pollicis longus (T) is continuous with the radial bursa (arrows). (Fig. 2A adapted from an original painting by Frank H. Netter, M.D., from Clinical Symposia. Copyright by CIBA Pharmaceutical Company, Division of Ciba-Geigy Corporation. All rights reserved.)

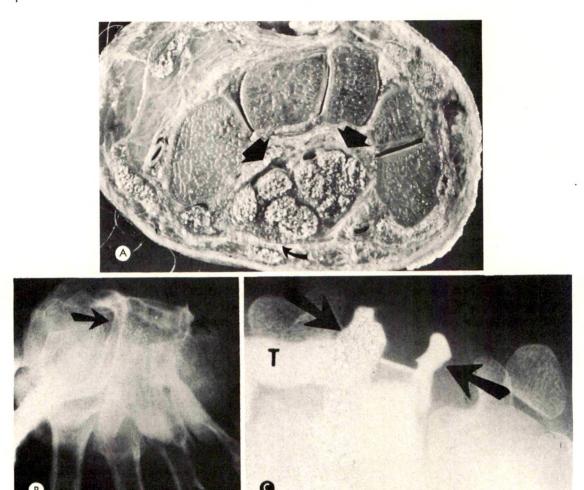


Fig. 4. The carpal tunnel.

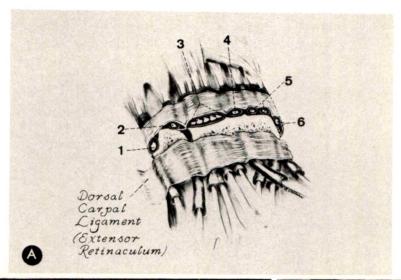
(A) A transverse cross section through the carpal bones outlines the flexor tendons and sheaths within the carpal canal (large straight arrows). The transverse carpal ligament (curved arrow) is apparent. (B) Contrast medium within the communicating radial and ulnar bursae delineates many flexor tendons within the carpal tunnel (arrows). (C) An injection of the sheath of the flexor pollicis longus (T) outlines a noncommunicating radial bursa (arrows) within the carpal tunnel.

and deep tendons of the index finger.<sup>5</sup> A separate carpal sheath, without communication with either radial or ulnar bursa, may be found enveloping the index flexor tendons.<sup>6</sup> Additionally, a small synovial sac may enclose the tendon of the flexor carpiradialis as it passes under the crest of the trapezium.<sup>6</sup>

## CARPAL TUNNEL (Fig. 4)

Tendons, vessels and nerves passing from the forearm to the hand must tra-

verse a canal on the volar surface of the wrist formed between a deep excavation on the undersurface of the carpal bones and the transverse volar carpal ligament. The latter extends in the wrist from the radial (inserting on the trapezium, navicular, and occasionally the radial styloid) to the ulnar side (inserting into the pisiform and hook of the hamate.) On its radial aspect a small opening in the volar carpal ligament as it bridges the trapezium produces a tunnel for the flexor carpi radialis tendon. Through the canal proper, which is triangular in



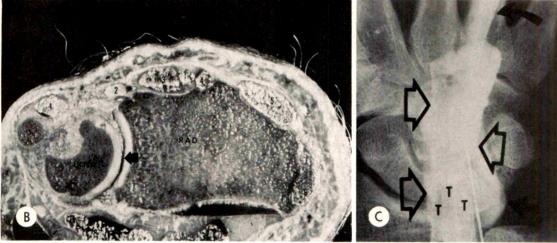


Fig. 5. Extensor tendon sheaths.

(A) The synovial sheaths passing beneath the dorsal carpal ligament are separated into 6 distinct compartments; the numbers correspond to those used in the text. (B) A transverse cross section through the distal radius (RAD), ulna, ulnar styloid (S) and inferior radio-ulnar joint (arrow) reveals the 6 compartments of the extensor tendons and sheaths. (C) An injection has been made into the sheath (open arrows) enclosing the tendons (T) of the extensor digitorum communis and extensor indicis proprius. A previous injection in the flexor digital sheath of the fifth finger (curved arrow) introduced contrast material which continued into the ulnar bursa (closed straight arrow).

transverse section, pass the digital flexor tendons and sheaths, and the median nerve. Compression of the latter may result in the carpal tunnel syndrome; this may be associated with local or systemic diseases.<sup>3,8,9</sup>

## EXTENSOR TENDON SHEATHS (Fig. 5)

Several synovial sheaths are located in

the dorsum of the wrist beneath the dorsal carpal ligament; they extend for a short distance above and below that ligament.<sup>6</sup> By insular attachments of the dorsal carpal ligament on the posterior and lateral surfaces of the radius and ulna, 6 distinct avenues are created for transport of ligamentous structures.<sup>5,7</sup> The most medial compartment contains the extensor carpi ulnaris tendon and sheath (4–5 cm. in

length) lying at the dorsomedial aspect of the distal ulna. In the second compartment, a long sheath (6-7 cm. in length) covers the extensor digiti quinti proprius which lies in close proximity to and may communicate with the inferior radio-ulnar joint.6 The third compartment on the posteromedial aspect of the radius contains a large sheath (5–6 cm. in length) enclosing the tendons of the extensor digitorum communis and the extensor indicis proprius. In the fourth compartment are the sheath (6–7 cm. in length) and tendon of the extensor pollicis longus. The sheath may extend as far distally as the trapezium or first metacarpal bone. Lateral to this in the fifth compartment are sheaths (5–6 cm. in length) covering the extensor carpi radialis longus and brevis which may communicate with the sheath of the extensor pollicis longus. Finally, a compartment along the lateral aspect of the radius contains a common synovial sheath (5-6 cm. in length) enclosing the abductor pollicis longus and extensor pollicis brevis.

### DISCUSSION

Tenography is a relatively simple radiographic technique, particularly in individuals in which exuberant synovial proliferation has resulted in distention of the synovial sheaths. This is frequent in rheumatoid arthritis.2 Although this study was confined to cadavers, our own experience and previous reports11,12 have indicated the practicality of similar techniques in patients. A ring block at the base of the injected finger<sup>11</sup> or local skin anesthesia is ample. Roentgenograms which may include anteroposterior, oblique and lateral projections must be taken within 5-10 minutes as contrast material diffusion will produce blurring on delayed roentgenograms.

A study of the anatomy of the synovial sheaths of the fingers, hand and wrist allows insight into the pathomechanics of certain disease processes. Thus, the frequency and distribution of "horseshoe abscesses" of the palm, <sup>1,7</sup> osteomyelitis and

septic arthritis accompanying hand infection are apparent. A future report will discuss in detail these particular aspects.

Tenography in the rheumatoid hand<sup>2</sup> allows accurate appraisal of the extent of synovial involvement, thereby assisting the surgeon. It may also allow further understanding of the pathogenesis of hand deformities in that disease.

Outlining the synovial sheath within the carpal tunnel may demonstrate local mechanical factors producing the carpal tunnel syndrome.

### SUMMARY

The radiographic anatomy of the tendon sheaths of the hand and wrist is described. Contrast evaluation, tenography, of these synovial-lined channels utilizing 10 cadaver limbs was accomplished outlining their relationship to adjacent osseous and articular structures.

The technique is simple and provides the radiologist with further understanding of the pattern and distribution of roentgenologic alterations accompanying septic and granulomatous processes of the hand and wrist including "horseshoe abscesses" of the palm, osteomyelitis, pyarthrosis, and rheumatoid tenosynovitis.

Tenography should be added to the radiologist's ever-increasing armamentarium.

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# THICKENING OF THE HEEL-PAD ASSOCIATED WITH LONG-TERM DILANTIN THERAPY\*

By KENNETH R. KATTAN, M.D. CINCINNATI, OHIO

DILANTIN (diphenylhydantoin), introduced in 1938, has become a standard drug in the treatment of epilepsy. Since 1938 a long list of side effects has been described. More recently bone changes<sup>1,6</sup> and coarse facies have been added to this list.

In a previous communication we reported thickening of the calvaria in some patients receiving Dilantin.<sup>4</sup> Thickening of the heel-pad in I of the patients with calvarial thickening was so significant that the possibility of acromegaly was raised. In the light of a recent communication about facial soft tissue changes secondary to Dilantin therapy,<sup>7</sup> an investigation of this roentgenologically visible change, namely the heel-pad thickness, was undertaken.

### MATERIAL AND METHOD

White patients from Longview State Hospital and Cincinnati General Hospital were selected for the study (1968–1973). Normal controls were drawn from demographically similar patients who consented to have a heel-pad roentgenogram at the time they were being roentgenographed for other, non-systemic causes.

Black patients were excluded because a general tendency toward thicker heel-pads was seen in the few patients available for study. Their number was too small for separate analysis. The heel-pad was measured according to Kho *et al.*<sup>5</sup> (Fig. 1). The cases were divided into 5 groups according to length of therapy:

- (I) Control
- (II) One or 2 years
- (III) Three to 5 years
- (IV) Six to 10 years

(V) More than 10 years of Dilantin treatment (Table 1 and Fig. 2).

For a more meaningful comparison according to age, sex, and length of treatment, the patients were divided into 2 large groups (Table II, and Fig. 3; 4; and 5): (1) Controls receiving no Dilantin, and patient receiving less than 3 years therapy (Groups I and II), and (2) those on Dilantin therapy for 3 years or more (Groups III, IV and V).

### RESULTS

The mean thickness of the heel-pad was 16.57 mm. in the control group and in-

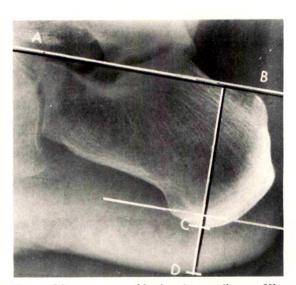


Fig. 1. Measurement of heel-pad according to Kho et al.<sup>5</sup> A line joining the anterior and posterior angles on the calcaneus (AB) is drawn. For convenience a parallel line is drawn near lower part of the calcaneus, and a perpendicular line is drawn from it, passing through the lowest point of the calcaneus. The distance between this point and the skin (CD) measured along the perpendicular is the heel-pad thickness.

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Group Years of Treatment	Number of Patients	Heel-Pad	Thickness	Heel-Pad Thicker Than 20 mm.	
		Mean mm.	Median mm.	Number of Patients	Per Cent
I. Control No Dilantin	43	16.57	16.5	1	2.4
II. 1-2	6	17.5	17.5	0	0
III. 3-5	10	19.35	19.5	3	30
IV. 6-10	19	19.16	19	5	26.3
V. 10 plus	12	20.63	21	7	58.3

creased steadily to 20.63 mm. in patients receiving Dilantin for more than 10 years. In the control group only 1 of 43 patients had a heel-pad thicker than 20 mm., while in Groups II, III, IV and V there were 0/6, 3/10, 5/19 and 7/12 patients, respectively, with heel-pads greater than 20 mm. The thickest heel-pad in the control group was 20.5 mm. In Groups II, III, IV and V the

largest measurements were 18, 23, 26 and 24 mm., respectively.

### DISCUSSION

In 1972, Lefebvre et al.7 observed gross

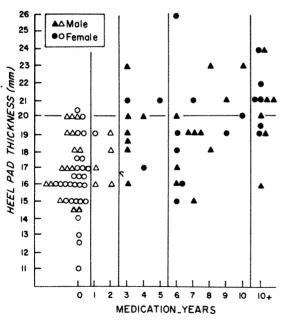


Fig. 2. Distribution of heel-pad thickness (in mm.), according to the duration of treatment (in years). Zero years signifies controls.

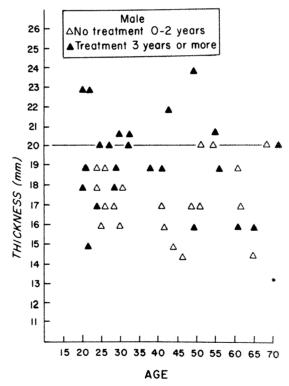


Fig. 3. Distribution of heel-pad thickness (mm.) in males. △ Controls and patients receiving treatment for less than 3 years. ▲ Patients receiving treatment for 3 years or more.

TABLE II
DIVISION INTO 2 LARGE GROUPS

Czoup	Number of Patients	Heel-Pad Thickness		Heel-Pad Thicker Than 20 mm.	
Group Years of Treatment		Mean mm.	Median mm.	Number of Patients	Per Cent
Groups I and II Combined 0-2 years	49	16.68	16.5	I	2
Groups III, IV, and V Combined 3 + years	41	19.64	19.5	15	36.8

enlargement of the lips, nose and generalized thickening of subcutaneous tissues of the face and scalp in patients receiving anticonvulsant medication for long periods. A review of the patients included in a

previous study from this institution focusing on Dilantin induced calvarial thickening, showed I patient with coarse facies and thickening of the soft tissues of the hand (Case I<sup>4</sup>). In another patient the heel-pad

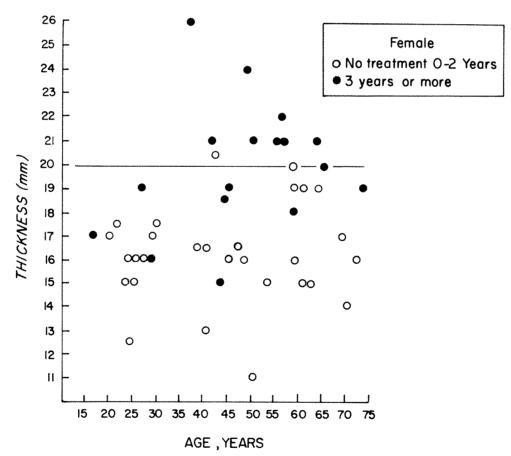


Fig. 4. Distribution of heel-pad thickness in females. O Controls and patients receiving treatment for less than 3 years. • Patients receiving treatment for 3 years or more.

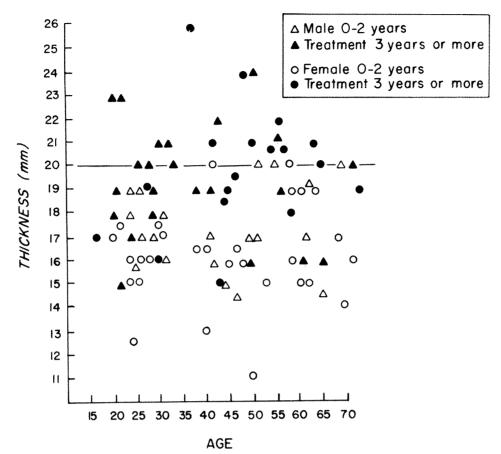


Fig. 5. Combination of Figures 4 and 5.

was so thick, that the original roentgenographic report raised the possibility of acromegaly.

The data show a definite trend with increasing heel-pad thickening practically paralleling increasing length of treatment (Table II; Fig. 2). This increase is evident in both the mean and median measurements. The percentage of patients manifesting an abnormally thickened heel-pad (>20 mm.) in each treatment subgroup also increases, and practically correlates with treatment interval. This difference in thickness is not due to age or sex (Fig. 3; and 4); nor does race play a part since all the patients are white.

In this study, the mean value in the control group falls slightly below (16.7 mm.) the normal value obtained by Stein-

bach and Russell (17.8 mm).<sup>12</sup> We have no explanation for this difference. However, we agree with these authors that any measurement above 20 mm. should be considered suspicious.

Dilantin therapy should be added to the gamut of causes for thickening of the heelpad. This list includes acromegaly, 2,5,12 obesity, injury, infection, peripheral edema and myxedema.

### SUMMARY AND CONCLUSION

Thickening of the heel-pad is added to the list of side effects of Dilantin medication.

Any measurement above 20 mm. in a white patient was considered abnormal. Only 1 of 43 controls measured above this value, while in patients receiving Dilantin

the percentage of patients manifesting abnormally thickened heel-pads increased steadily with length of treatment; after 10 years 7 out of 12 patients showed this change.

Dilantin medication should be included in the differential diagnosis of heel-pad

thickening.

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### PSEUDO-MALIGNANT LESIONS IN PAGET'S DISEASE OF BONE\*

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HE development of sarcoma is a well known complication of Paget's disease of bone.1 Less well recognized is the occasional occurrence of ominous-appearing lesions of bone that mimic malignancy, but are actually benign manifestations of

Paget's disease.

Two patients with widespread Paget's disease of the skeleton were seen with focal lesions of the lower extremity that were initially interpreted as malignancy. One had a juxtacortical soft tissue mass that simulated an osteosarcoma; the second, an osteolytic lesion of the mid-tibia that expanded the cortex. Biopsy of each lesion showed uncomplicated Paget's disease.

### REPORT OF CASES

CASE I. R.F. (Johns Hopkins Hospital history No. 79-04-18.) A 72 year old woman complained of left knee and groin pain of several weeks' duration. Four weeks prior to admission, she noted left knee swelling and remained in bed. Physical examination showed warmth and erythema of the left knee. Hematocrit, hemoglobin and white blood cell count were normal. The serum calcium was 9.7 mg. per 100 ml., phosphorus 3.8 mg. per 100 ml., and alkaline phosphatase 650 international milliunits (normal range = 10-32 milliunits).

Roentgenograms of the pelvis and left femur were made and the findings led to a partial skeletal survey. The pelvis, lumbar spine and femora showed coarse trabeculae and increased density indicating Paget's disease. A number of thoracic and cervical vertebral bodies were characteristically enlarged and sclerotic. At the medial aspect of the distal femur, a lobulated, periosteally based mass was identified having a density slightly greater than that of water (Fig. 1). The cortex immediately beneath the

lesion was not destroyed. The contiguous bone and the remainder of the distal femur were markedly involved with the sclerotic phase of Paget's disease. In the diaphysis, a radiolucent early phase of Paget's disease was present. The preoperative clinical and roentgenographic diagnosis was sarcoma complicating Paget's disease. In December, 1969, a biopsy was performed in the central region of the mass and a portion of the femoral cortex was also removed. Histologic examination showed Paget's disease without neoplasia (Fig. 2, A-C). The patient returned to the hospital in August, 1971 for

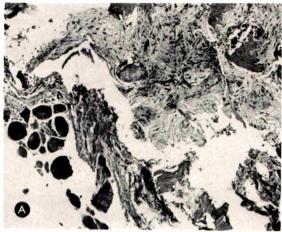


Fig. 1. Case 1. The arrows denote the juxtacortical soft tissue mass at the distal diaphysis in October, 1969. A predominantly sclerotic phase of Paget's disease is present in the distal femur.

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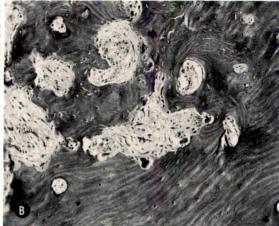
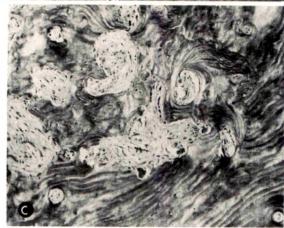


Fig. 2. Case I. (A) A low power (×100) view of the outer border of the biopsy sample shows muscle, fibrous and bony tissue. (B) A second microscopic field (×100) in ordinary light shows the Paget's bone which comprised most of the biopsy material. (C) The same field in B (×100) is shown in partially polarized light to emphasize the mosaic pattern of collagen birefringence of Paget's disease.



evaluation and treatment of congestive heart failure. A roentgenogram of the left femur showed no change in the appearance of the mass or underlying Paget's disease (Fig. 3). The biopsy site had healed.

CASE II. A.G. (Johns Hopkins history No. 77-70-72.) A 59 year old woman complained of a "knot" on the right lower leg. On physical examination, she had a slightly raised, irregular, non-tender swelling anterior to the midtibia. Roentgenograms showed a radiolucent zone in the mid-tibia that expanded the tibia anteriorly and had "V" shaped margins on both ends (Fig. 4, A and B). The tibia, proximal and distal to the lesion, was normal (Fig. 5, A and B), but the talus was sclerotic and expanded in the anteroposterior plane, suggestive of Paget's disease (Fig. 6, A and B). A bone survey showed Paget's disease of the lower dorsal and the upper lumbar vertebral bodies and the left hemipelvis. Both clinically and roentgenologically, the mid-tibial lesion was considered a destructive lytic lesion, probably a tumor or possibly Paget's disease. Biopsies of the left iliac crest and the right tibial lesion were interpreted as Paget's disease and a benign fibro-osseous lesion, respectively (Fig. 7). Dr. Lent Johnson of the Armed Forces Institute of Pathology was asked to review the histologic sections. His diagnosis for both specimens was Paget's disease. The patient has been well since discharge. Roentgenograms of the lesion in the mid-tibia in December, 1973 showed extension throughout most of the anterior upper portion of the tibia.

### DISCUSSION

Case I exhibits the feature of new Paget's bone laid down on old Paget's bone in an extensive focal manner. The roentgenographic and clinical impression of a mass lesion led to confusion of the periosteal response with a superimposed sarcoma or giant cell tumor. Although giant cell tumors



Fig. 3. Case I. The healed biopsy site (arrows) indents the soft tissue margin of the paraosseous mass. In this roentgenogram made in August 1971, the mass is relatively unchanged over a period of 22 months.

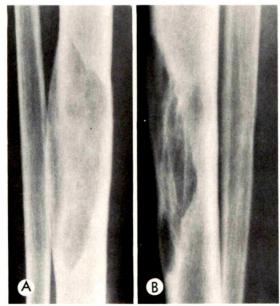


Fig. 4. Case II. (A) The anterior view of the tibial lesion shows its "V" shaped upper and lower margins. (B) The lateral view shows its eccentric location and zones of focal expansion of the cortex.



Fig. 5. Case II. (A and B) The tibia proximal and distal to the lesion is normal.

in Paget's disease predominantly occur in the facial bones and skull, sites in long bones have been reported. It is tempting to speculate that injury to the surface of the distal femur led to a stimulus for new bone and that Paget's bone was the result. The patient did injure the left knee 6 months





Fig. 6. Case II. (A) There is marked sclerosis of the talus in the anterior view. (B) The lateral view shows the expansion, sclerosis and coarse trabecular pattern of Paget's disease.

prior to admission. Paraosseous masses in the spine affected by Paget's disease have been shown as extradural compression defects at myelography. Such parosseous masses may be analogous to the subperiosteal Paget's bone in our case. To our knowledge, a similar example with histologic evidence of the new Paget's bone is not previously reported.

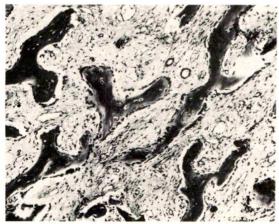


Fig. 7. Case II. Ordinary light microscopic field (X100) of early Paget's disease. Osteoblasts outline trabeculae in a background of fibrous tissue.

The early osteolytic, aggressive phase of Paget's disease is rarely discovered confined to the mid-shaft of a long bone. Usually the disease begins in one end of the bone in a subarticular location and then advances distally or proximally. We have discovered only four references to a midbone site of the osteolytic phase of Paget's disease. And In each, the site was the anterior mid-portion of the tibia as in our patient.

Brailsford<sup>2</sup> listed the site of discovery of Paget's disease in 154 patients. The pelvis was the first site of detection in 58 cases; the tibia was the first site in 37 patients. The femur represented the third most common initial site of detection with 22 patients. Brailsford considered that the frequency of involvement in the pelvis was wholly circumstantial and related to the frequent roentgenography of that body area in lumbar spine, gastrointestinal and genitourinary examinations.

At least 3 of the patients with a midtibial lesion were of a relatively young age. Kasabach and Dykes' patient was 33 years of age when he developed pain in the left leg. Brailsford's patient was 27 years old and had noted swelling over the tibial tubercle. Of Brailsford's 154 patients with Paget's disease, this man was the youngest. Seaman<sup>8</sup> reported 2 patients, both men, of ages 27 and 34 years. The 27 year old patient had been treated for prostatitis and urethritis since the age of 19. No evidence of gonorrhea or syphilis had been found. On one of his regular visits he complained of a mild dull aching pain in the right lower leg and a roentgenogram showed a lesion similar to that in Case II. The lesion in Seaman's second patient was noted as a swelling over the anterior right tibia during an examination for severe headache. The patient had noticed leg pain when running in the 6 months prior to that physical examination. Thus a patient with a mid-tibial lesion of the early phase of Paget's disease tends to be a young patient between the ages of 20-35 years, unlike our Case II, who was 59 years of age.

### SUMMARY

Two patients with unusual features of Paget's disease are reported.

In one patient a circumferential focal and periosteally based mass of Paget's disease presented as a mass lesion superimposed on the sclerotic phase of Paget's disease in the distal femur. Biopsy of the mass showed Paget's disease without neoplasia. The mass has remained unchanged roent-genographically in a 2 year period.

In a second patient, a lesion occurred in

the mid-portion of the tibia and showed features of the early and radiolucent phase of Paget's disease.

In a 4 year period, the lesion has progressed to a more sclerotic phase and to occupy the proximal end of the tibia as well as its mid and lower portions.

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# PATTERNS OF MIGRATION OF THE FEMORAL HEAD IN OSTEOARTHRITIS OF THE HIP\*

## ROENTGENOGRAPHIC-PATHOLOGIC CORRELATION AND COMPARISON WITH RHEUMATOID ARTHRITIS

By DONALD RESNICK, M.D. SAN DIEGO, CALIFORNIA

STEOARTHRITIS of the human frame is ubiquitous; involvement of the hip is most frequent and may have devastating clinical results. Roentgenographic evaluation reveals features common to many degenerating joints including joint space narrowing, sclerosis, and osteophytosis. Characteristic patterns of femoral head migration in the osteoarthritic hip are rarely described in the American radiologic literature and are omitted, in large part, from standard textbooks of skeletal radiology.4 In addition, roentgenographic-pathologic correlation of the osteoarthritic changes has not been emphasized. This is surprising in an age in which total hip replacements are becoming commonplace, providing abundant pathologic material.

It is the purpose of this study to define the patterns of migration of the femoral head in the osteoarthritic hip, correlating the roentgenographic and pathologic alterations, and compare them with those occurring in rheumatoid arthritis.

### MATERIAL AND METHOD

The evaluation of osteoarthritic abnormalities was accomplished utilizing:

- a. Roentgenograms of 100 patients with "primary" osteoarthritis of the hip. In all instances no evidence of underlying disease process or trauma could be elicited; no historical evidence suggesting Legg-Perthes disease or slipped femoral capital epiphysis could be obtained.
- b. Thirty femoral heads removed during total hip replacements. In these instances the specimens were sectioned,

roentgenographed, and photographed. Microscopic sections of the entire femoral heads were prepared by fixing slabs of 1 to 3 cm. in thickness for 1 week in neutral buffered formic acid, and dehydrating in ethanol. Specimens were then double-embedded with 4 per cent celloidin in methyl benzoate and paraffin. Eight to 10 micron sections were then cut on a sledge microtome and stained with hematoxylin and eosin.

Comparison with rheumatoid arthritis was accomplished by studying abnormal hip roentgenograms in 15 rheumatoid patients and the available pathologic material.

### RESULTS

The roentgenographic evaluation included an analysis of cardinal roentgenographic signs of articular disease including joint space narrowing, sclerosis, cysts, and osteophytosis. The acetabular depth was measured utilizing the CE angle.27 This angle can be determined by drawing a line connecting the centers of both femoral heads. A second straight line is constructed through the center of the femoral head and the edge of the acetabular articular surface. The angle formed between the second line and the vertical is the CE angle and has been established in "controls;" in females it ranges from 26-45°, and in males, 23-47°.15 Structural changes of the acetabulum such as marginal osteophytes and protrusion deformity make evaluation of CE angles difficult in longstanding osteoarthritis. In these instances

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one must ignore marginal new bone formation in the calculation; earlier roentgenograms before the onset of deforming arthritis are particularly helpful. The axes of migration of the femoral head were divided into superior, axial and medial directions (Fig. 1).

### **OSTEOARTHRITIS**

In all 100 patients with osteoarthritis the femoral head moved in either superior or medial directions; there were no instances of axial movement (Table 1).

A superolateral pattern of femoral head migration was observed in 15 individuals (15 per cent) (Fig. 2). There were 10 females and 5 males and in 7 patients bilateral although asymmetric abnormalities were noted; the contralateral hip frequently revealed a shallow acetabulum without additional roentgenographic abnormality. In most of the 15 patients CE angles were in the lower limits of normal or decreased. The femoral head migrated toward the outer proximal lip of the shallow-appearing acetabulum. Joint space narrowing and sclerosis were apparent in the outer one-third of the joint and were accompanied by subcortical cystic lesions. These were noted in both acetabular and femoral portions. The femoral head was significantly flattened in two-thirds of the individuals and in these cases sclerosis was extreme. Substantial lateral displacement of the femoral head in advanced cases re-

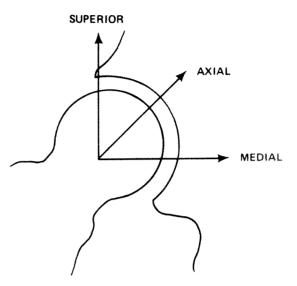


Fig. 1. Classification of femoral head migration.

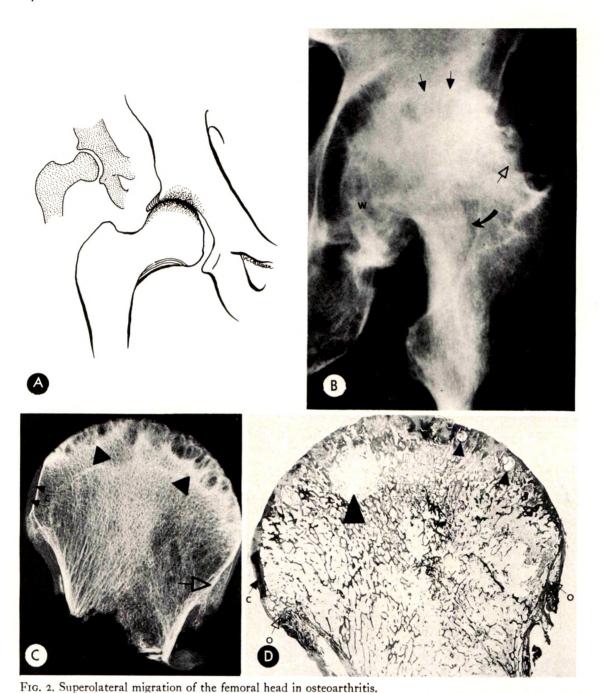
sulted in widening of the inferomedial portion of the joint space. Buttressing of the femoral neck was common, predominantly involving its medial cortex. Osteophytosis was a minor feature in most of the patients and was most frequently noted on the lateral aspect of the femoral head.

Histologic evaluation of femoral heads demonstrating this type of migratory pattern outlined articular cartilage loss along the outer one-third of the femoral surface with relative preservation of cartilage along the inner and medial aspects of the femoral head. Thickening of stress trabeculae and reactive new bone formation were apparent and single or multiple cystic le-

Table I

FEMORAL HEAD MIGRATION IN OSTEOARTHRITIS

Pattern	Frequency (Per Cent)	Joint Space Narrowing	Predominant Osteophytes	Femoral Neck Buttressing *
Superior	78			
Superolateral	15	Superior	Lateral acetabulum Lateral femur	Medial>Lateral
Superomedial	48	Superior, Middle	Lateral acetabulum Medial femur	Medial>Lateral
Intermediate	15	Superior, Middle	Lateral acetabulum Medial femur	Medial>Lateral
Medial	22	Inferior, Middle	Medial, lateral acetabulum Medial, lateral femur	Medial>Lateral



(A) Progressive narrowing of the outer one-third of the joint space, with adjacent sclerosis, lateral acetabular osteophytes and medial femoral neck buttressing. (B) Joint space narrowing and sclerosis (closed straight arrows) along the superior articulating surface are associated with subchondral collapse of the adjacent femoral head. A lateral osteophyte (open arrow), widened inferomedial joint space (W) and medial femoral neck buttressing (closed curved arrow) are noted. (C) A roentgenogram of a longitudinal

section of the femoral head from the same patient reveals diffuse loss of cartilage with a remnant along its medial third (C). Subchondral cysts with sclerotic margins (arrowheads) and lateral femoral osteophytes (open arrow) are apparent. (D) A photomicrograph ( $\times 4$ ) outlines small and large subchondral cysts (arrowheads) with surrounding sclerosis, intact cartilage along the medial aspect of the femoral head (C) and medial and lateral osteophytes (O).

sions with sclerotic margins were evident along the superior subchondral bone of the femoral head.

A superomedial pattern of femoral head migration was noted in 48 patients (48 per cent) (Fig. 3). There were 38 males and 10 females. In 32 patients contralateral osteoarthritic abnormalities in the hip were evident, and although some degree of asymmetry was frequently present the pattern of femoral head displacement was comparable in most of these individuals. In several patients in this group the contralateral hip demonstrated migration of the superolateral type. The superomedial pattern of displacement, which appears identical to that of a "tilt deformity" described by others,15 was associated with normal CE angles, although in several patients the values fell within the lower portion of the normal spectrum. Joint space narrowing was initially noted in the superior aspect of the articular cavity but eventually became extensive; large portions of the lateral and middle thirds of the acetabulum and femoral head were closely applied to each other obliterating most of the joint space. In many instances the sclerotic subchondral bone along the acetabulum and femur appeared surprisingly distinct. This was in contrast to indistinct sclerotic bone which was apparent along the outer margins of the joint space with superolateral femoral head displacement. Gradual "shifting" in a medial and inferior direction created apparent tilting in which the head, flattened superiorly, appeared to slide off the femoral neck. Buttressing of the femoral neck was found on both medial and lateral sides but predominated in the former location. Acetabular cysts were frequently evident; femoral head cysts were often small and multiple, located within a long segment of the subchondral bone. Osteophytes were a significant roentgenographic feature; they were of large size and noted on the lateral aspect of the acetabulum and medial portion of the femoral head. In the latter location they extended for considerable distances in an inferior direction. Broad but shallow osteophytes were noted on the lateral surface of the femoral neck.

Microscopic evaluation in this group confirmed the widespread loss of hyaline cartilage which frequently extended across the entire articular surface. Small subchondral lucencies, often piriform in shape, were noted in the femoral heads. Less commonly they extended into the deeper portions of the bone. The superior surfaces of the femoral heads were flattened and sclerotic; osteophytes of considerable size were found on their inferior aspects. In addition, in some specimens, shallow broad osteophytes covered portions of the femoral surface.

An additional pattern of superior femoral head migration was noted in 15 patients (15 per cent) (Fig. 4). It combined roent-genographic features found in both the superolateral and superomedial displacements. CE angles were within the lower limits of normal. A laterally displaced femoral head was associated with mild "tilting," osteophytosis along its inferior aspect, and joint space narrowing, sclerosis, and cyst formation mainly confined to its outer one-third.

Medial migration of the femoral head was noted in 22 individuals (22 per cent) (Fig. 5). There were 14 males and 8 females and the changes were bilateral and relatively symmetric in 15. The CE angles were often increased because of an associated mild protrusio deformity. This displacement of the femoral head was in an inferomedial direction; the medial joint space narrowed and associated widening of the lateral joint space was apparent. This asymmetry is important in differentiating medial from axial displacement. Increased bone density was commonly noted in the central and inferior acetabulum, particularly when protrusio deformities were present. Medial buttressing of the femoral neck was more frequent and extensive than lateral buttressing. Osteophyte formation occurred on both acetabulum and femur, being most extensive on the lateral lip of

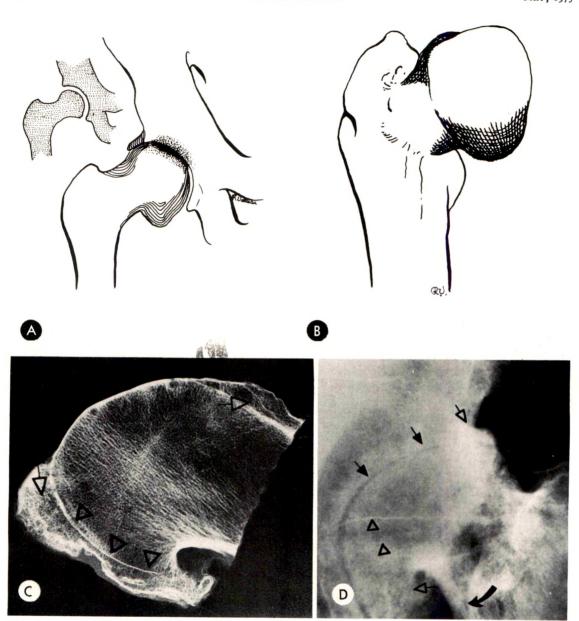


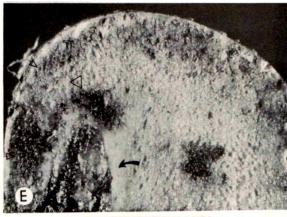
Fig. 3. Superomedial migration of the femoral head in osteoarthritis.

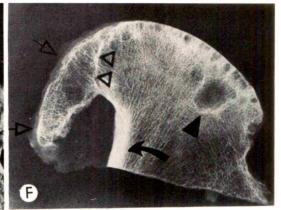
(A) Progressive resorption of bone along the lateral femoral head and deposition along its medial aspect result in a "tilt" deformity. (B) Osteophyte formation (cross-hatched areas) is most prominent on the inferomedial aspect of the femoral head (anterior view). (C) A sectional roentgenogram reveals bony deposition on the inferomedial and superolateral surfaces (open arrows) of the femoral head. On the medial side, the osteophyte has formed between the original calcified zone of articular cartilage (arrow-heads) and joint surface. (D) A hip roentgenogram demonstrates superior and middle joint space loss and subchondral sclerosis (closed straight arrows), medial femoral neck buttressing (closed curved arrow), and small lateral acetabular and massive medial femoral osteophytes (open arrows). The original calcified cartilaginous zone (arrowheads) is faintly visible.

the acetabulum and medial portion of the femoral head. Mild protrusio deformity was a characteristic abnormality.

On microscopic examination the cartilage

loss was apparent in the central and inferior portions of the femoral head; small subchondral cysts were commonly noted in the same location.





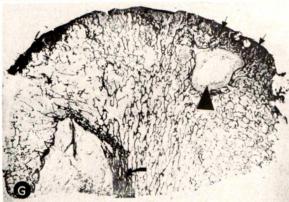


Fig. 3. (E) A longitudinal slice from the same osteoarthritic femoral head passes through the medial femoral osteophyte (open arrows) which contains red marrow. The original calcified zone of articular cartilage (arrowhead) and medial femoral neck buttressing (curved arrow) are seen. (F) The radiographed specimen contains small and large subchondral cysts (closed arrowhead). Articular cartilage still covers the medial osteophyte (open arrows), and the original calcified cartilaginous zone (open arrowheads) is well shown. Buttressing is noted (curved arrow). (G) The photomicrograph (X4) demonstrates bony sclerosis (closed straight arrows), subchondral

cysts (arrowhead), femoral neck buttressing (curved arrow) and the large medial osteophyte (open arrows).

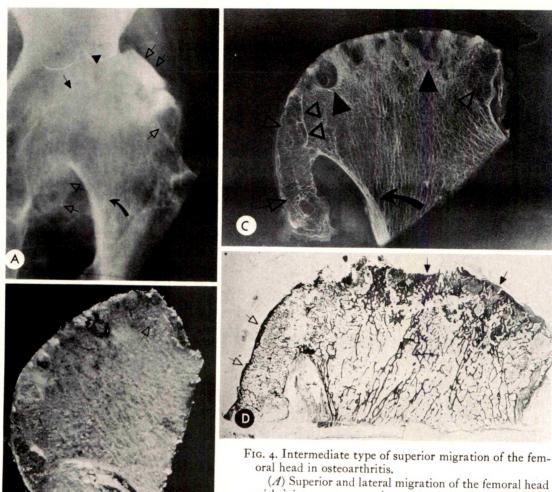
### RHEUMATOID ARTHRITIS

Two types of femoral head migration were noted in patients with rheumatoid arthritis, superior and axial; no evidence of medial displacement of the femoral head was found.

Axial displacement of the femoral head was most frequent (Fig. 6); the roentgenographic appearances varied from diffuse joint space narrowing without protrusio to protrusio deformities of varying severity. The incidence of severe hip disease was higher in steroid-treated patients. Roentgenographic features allowing distinction from osteoarthritis included demineralization, symmetrical joint space loss, relative absence of buttressing and osteophytosis, and moderate or severe protrusio deformity. In several patients superimposed degenerative changes were apparent although none demonstrated large osteo-

phytes or considerable buttressing. Extensive bony disintegration of the femoral head was apparent in some steroid-treated patients.

Superior displacements of the femoral head were noted in 3 rheumatoid patients (Fig. 7). They were bilateral in each, and in 2 of the 3, the CE angles appeared decreased. The lateral displacement of the femoral head was not so marked as in cases of osteoarthritis. Considerable eburnation along the lateral portions of the acetabulum and head of the femur was associated with subchondral cystic abnormality. Osteophytosis was a minor feature, being noted on the lateral femoral and acetabular margins of the joint. In I patient histologic evaluation following bilateral total hip replacement revealed considerable cartilage loss, variable sized cysts, and lateral femoral osteophytes.



with joint space narrowing and subchondral collapse of bone (closed arrow), cysts (arrowhead), lateral and medial osteophytes (open arrows) and buttressing (curved arrow). (B) A longitudinal slice of the femoral head reveals medial and lateral osteophytes (open arrows). (C) The corresponding roentgenogram outlines cartilage-

clothed osteophytes (open arrows), subchondral cysts (closed arrowheads), buttressing (curved arrow) and the original calcified cartilaginous zone (open arrowheads). (D) Extensive cartilaginous destruction and bone sclerosis on the superior femoral surface (closed arrows) and the large medial osteophyte (open arrows) are noted on the photomicrograph  $(\times_4)$ .

### DISCUSSION

PATHOLOGIC ALTERATIONS IN OSTEOARTHRITIS

The pathologic alterations in the osteoarthritic hip have received considerable attention.3,5,26 Methods of correlating pathologic and roentgenologic findings have also been described.14 Most investigators believe that articular cartilage is the initial site of tissue change. Deleterious effects on cartilage in zones of excess pressure are well documented experimentally and resemble

those occurring in osteoarthritis.24 The pathogenesis of such pressure necrosis may relate to interference with the diffusion of nutritives through the intercellular cartilaginous substance.22 Alternately, habitual noncontact may produce cartilage degeneration<sup>2</sup> and explain surface fibrillation in the peripheral and perifoveal areas of the femoral head. Perhaps a "pumping" mechanism is necessary to insure proper nutrition by allowing synovial fluid to penetrate

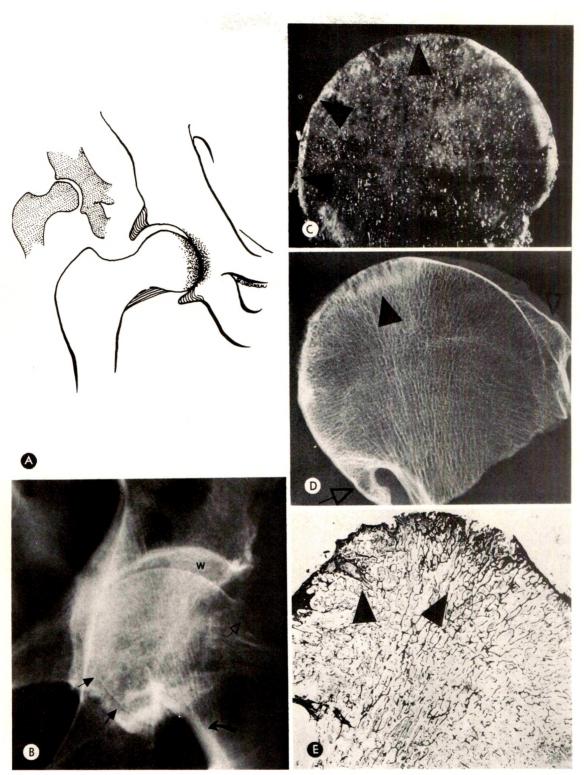


Fig. 5. Medial migration of the femoral head in osteoarthritis.

(A) As the femoral head migrates medially, joint space narrowing and sclerosis of the inferomedial aspect of the articular surface result, and the superior joint space widens. (B) Medial joint space loss (closed arrows) and a widened lateral joint space (W) have resulted from this pattern of migration. A lateral femoral osteophyte (open arrow) and medial femoral neck buttressing (curved arrow) are evident. Mild protrusio deformity is seen. (C) A longitudinal slice outlines cartilage degeneration most apparent in the middle and inferior portions of the femoral head (arrowheads). (D) The corresponding roentgenogram reveals the lateral and medial femoral osteophytes (open arrows), intact lateral articular cartilage, and sclerotic subchondral bone (arrowhead). (E) A photomicrograph (×4) demonstrates extensive sclerosis involving the middle portion of the articular surface (arrowheads).



Fig. 6. Axial migration of the femoral head in rheumatoid arthritis.

The acetabulum is being wrapped about the protruding femoral head. The acetabular bone is compressed (closed arrows) and small osteophytes may be identified (open arrow). Mild buttressing along the medial femoral neck is evident.

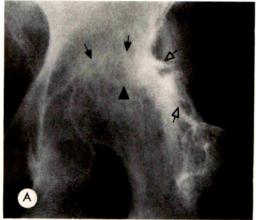
into deeper layers of cartilage.25 It would appear that the age-dependent cartilage degeneration appearing in nonpressure areas is less important in the pathogenesis of osteoarthritis than cartilage failure in areas of habitual contact and excessive pressure.2 It is the progressive cartilage loss in pressure areas which produces joint space narrowing leading to characteristic patterns of femoral head migration. Osteogenesis producing sclerosis in the osteoarthritic femoral head occurs in characteristic areas. Hypervascularity with venous engorgement is noted<sup>1,17-19</sup> particularly in the subchondral bone of the pressure segment.25 These same areas show maximal osteogenic activity; bone regeneration is related both to endochondral and appositional ossification.<sup>11</sup> In sclerotic bone in the pressure areas, the trabeculae are thickened; new bone is laid down upon the surface of pre-existing and often necrotic bone.

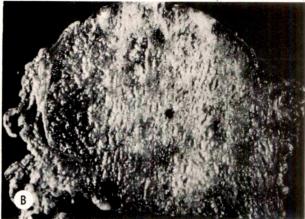
The bone cysts of osteoarthritis appear as single or multiple subchondral lucencies of varying size. They are usually confined to pressure segments in the femoral head and acetabulum<sup>25</sup>; the overlying cartilage is invariably abnormal. Many of the cysts show obvious communication with the joint; some observers believe that although fibrocartilaginous debris may occlude such communicating channels, the cysts originate from intrusion of synovial fluid through crevices in degenerating cartilage into the bony interstices, 12 while others believe they originate in areas of primary bone necrosis.5 The cystic lesions may be circular or piriform and frequently possess sclerotic margins.11,12

Osteophytes are a characteristic roentgenographic and pathologic feature of osteoarthritis. Marginal exostoses appear at the periphery of the articulating surfaces at which articular cartilage becomes continuous with periosteum.<sup>10</sup> Vascularization of subchondral bone and cartilage produces endochondral bone formation creating ledges of new bone at the joint margins. Flat exostoses10 beneath articular cartilage produce shifting of bone-cartilage borders, and a bumpy irregularity to the articular contour. Reduplication of cartilage<sup>10</sup> in which new bone is laid down between the original calcified cartilage zone and the joint surface may be noted. This is particularly prominent along the medial "low pressure area" of the femoral head; the tendency of osteophytes is to grow into free spaces within the joint cavity.25 Periosteal osteophytes<sup>10</sup> arising on the femoral neck result from stimulation of new bone formation by the synovial membrane.

## PATTERNS OF FEMORAL HEAD MIGRATION IN OSTEOARTHRITIS

Previous studies of osteoarthritis of the hip have attempted classifications based upon roentgenographic appearances;<sup>6,8</sup> others have tried to implicate specific etiologies in the production of roentgenographic alterations in the osteoarthritic hip.<sup>15</sup> We have found it useful to define 3





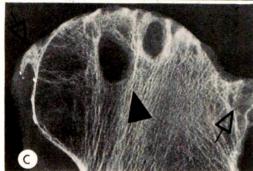


Fig. 7. Superior migration of the femoral head in rheumatoid arthritis.

(A) Joint space narrowing, bony eburnation (closed arrows) and subchondral cysts (arrowhead) along the superior aspect of the articular surface are noted. A narrow elongated acetabular and broad irregular femoral osteophyte (open arrows) are apparent. (B and C) A longitudinal section and corresponding roentgenogram outline extensive cartilage loss, large subchondral cysts (arrowhead) and osteophytosis (open arrows).

characteristic patterns of femoral head migration in these patients. In 85 of 100 patients, the displacement of the femoral heads fell clearly into 1 of these 3 categories.

Superolateral migration. This pattern, which has previously been termed "proximal arthrosis,"8 was noted in 15 per cent of our patients. It has been attributed to acetabular dysplasia;15 evaluation of CE angles in this study and others<sup>15</sup> has revealed small values indicating shallow acetabular cavities. The acetabulum changes its shape during development; it is a deeply set cavity during embryonic growth, becoming more shallow at birth, and then reversing the trend, deepening throughout childhood.20 Osteoarthritis developing in instances of acetabular dysplasia produces superior and lateral migration of the femoral head, superior joint space loss, and collapse of the superolateral aspect of the femoral head. It is more frequent in females15 and unilateral or asymmetric.6

Superomedial migration. The distinctive pattern of superomedial migration of the femoral head was noted in 48 per cent of the patients. A previous study described this pattern as the "tilt" deformity and noted it in 39.5 per cent of 200 osteoarthritic patients.15 It is more frequent in males, commonly bilateral, and may become symptomatic at an earlier age. The etiology is unknown; some suggest its relationship to abnormal adolescent stress and minor epiphysiolysis. 15 Although its resemblance to degenerative arthritis complicating known cases of slipped femoral capital epiphysis is apparent16 and its occurrence is in some patients who on close questioning admit to "growing pains,"15 the tilting of the femoral head would appear in many instances to relate solely to remodeling in the osteoarthritic joint. The bony trabeculae along the superior aspect of the femoral head within the pressure area, weakened by cyst formation and hyperemia, fracture and collapse; the flattened femoral head migrates superiorly

and slightly laterally, increasing the width of the inferomedial aspect of the joint space.25 The lack of osseous contact and low pressure in this latter area stimulate osteophyte formation. Roentgenograms of slabs of the osteoarthritic heads demonstrate osseous tissue between the original calcified zone of articular cartilage and joint surface. The gradually increasing remodeling process results in resorption of bone in the superior surface of the femoral head and deposition of new bone on its inferomedial surface, producing the apparent "tilt" deformity. In several of our patients available roentgenograms prior to the onset of significant osteoarthritis revealed no evidence of epiphysiolysis; measurements of the "femoral head ratios" were within normal limits.

The basic difference between this pattern of migration and that occurring in acetabular dysplasia is that in cases of shallow acetabula the femoral head continues to migrate outward until restraining osteophytes are formed on the lateral aspect of the acetabulum, at which time subluxation may cease; osteophyte formation is then noted on the inferomedial aspect of the femoral head. In superomedial migration, the acetabular depth is normal and, although minor degrees of lateral movement occur, restraining acetabular osteophytes often appear before considerable lateral subluxation is noted. Compression and flattening of the lateral femoral head and prominent medial osteophytes are noted.

An intermediate pattern of superior migration was noted in 15 per cent of our patients. In these individuals, CE angles were borderline or slightly decreased. The degree of lateral subluxation was less than in the superolateral group, but greater than that appearing in the superomedial pattern of migration. The remodeling process was again noted with collapse of the lateral aspect of the femoral head and medial osteophyte formation.

Medial migration. In 22 per cent of our osteoarthritic patients medial migration of

the femoral head occurred. This pattern which was noted in 35 per cent of 200 patients with osteoarthritis of the hip15 is commonly bilateral and symmetric<sup>6</sup> and has been more frequently described in females.15 In this series men predominated, but the patient population reviewed in this report included inordinate numbers of male patients. Some regard this type of osteoarthritis as idiopathic,15 although others describe underlying deviations from normal acetabular anatomy.8 These have included medial flattening and accentuated curvature of the lateral aspect of the acetabular roof, and deep acetabula with large CE angles. It would be interesting to speculate that specific idiosyncrasies in the acetabular structure produce stress in what otherwise would be a medial nonpressure area,25 gradual loss of the medial femoral articular cartilage and joint space, and mild protrusio deformity. This is the only pattern of femoral head migration in osteoarthritis in which femoral head protrusion is found. Associated medial buttressing along the femoral neck has been attributed to capsular fibrosis associated with adduction deformity.13 No consistent evidence for coxa vara deformities of the femur in our patients with medial migration could be found; such a deformity if present might predispose to medial joint space loss by altering the direction of mechanical forces.

## PATTERNS OF FEMORAL HEAD MIGRATION IN RHEUMATOID ARTHRITIS

The femoral head is displaced in one of two directions in rheumatoid arthritis. A more frequent axial migration results in symmetric loss of joint space; the displacement of the femoral head is in a craniomedial direction along the axis of the femoral neck. This has been noted by others and associated with normal CE angles. The protrusio deformity which may result is frequently severe, particularly in patients treated with steroid medication; osteophytosis and buttressing are minor roentgenographic features.

Superior migration of the femoral head

was noted in a few rheumatoid hips. The displacement, which has been termed "proximal" by others, is associated with mild subluxation and subnormal CE angles. It may resemble the superolateral migratory pattern of osteoarthritis, although productive changes including sclerosis and osteophytosis are less striking.

### PROTRUSIO DEFORMITIES

Analysis of this group of osteoarthritic hips reveals that medial protrusio deformity is essentially the only type that occurs in uncomplicated degenerative arthritis. Axial protrusion is a feature of rheumatoid arthritis. It may also complicate septic arthritis, particularly tuberculosis.<sup>9</sup>

If one notes hip roentgenograms in which axial migration of the femoral head is combined with obvious osteoarthritic features including sclerosis, osteophytosis and cortical buttressing, one must consider several etiologies. Idiopathic familial protrusio deformity may be associated with secondary osteoarthritis.23 Osteoarthritis may be superimposed on the axial protrusio deformities complicating bone-softening processes such as Paget's disease and osteomalacia.7.21 Degenerative features may also be noted in combination with rheumatoid arthritis. Not infrequently we have found axial migration of the femoral head and osteophytosis as roentgenographic features of hip involvement in ankylosing spondylitis.

### SUMMARY

Characteristic roentgenographic patterns of femoral head migration occur in osteoarthritis of the hip.

In a study of 100 patients superolateral migration was noted in 15, superomedial in 48, superior migration of intermediate type in 15, and medial displacement of the femoral head in 22.

Correlation with pathologic specimens obtained following total hip replacements and comparison with patterns of femoral head migration in rheumatoid arthritis were accomplished.

It would appear that anatomic features of the acetabulum are of prime importance in the determination of the type of femoral head displacement complicating osteoarthritis.

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### ROENTGENOGRAPHIC FINDINGS IN FUCOSIDOSIS TYPE 2\*

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 ${
m F}_{
m lysosomal}^{
m UCOSIDOSIS}$  is an autosomal recessive lysosomal disorder which has been classified with the mucolipidoses.17 The basic defect is a deficiency of alpha-Lfucosidase which results in neurovisceral storage of fucose-rich glycolipids, glycoproteins, and mucopolysaccharides. 2,5,14,20 Severe psychomotor regression occurs during the second year of life.

The first patients recognized to have fucosidosis were reported by Durand et al.3 in 1966. They were 2 siblings, products of first cousin matings, who had progressive mental deterioration, spasticity, repeated respiratory infections, thick skin, and abundant sweating. Their basic metabolic defect was shown to be a deficiency of alpha-L-fucosidase.20 Both patients died before 6 years of age. A total of 9 patients with this disease has been reported so far, primarily from a clinical, pathologic, and biochemical viewpoint.3,4,6,7,13-16 The presence of genetic heterogeneity has recently been recognized, and at least 2 forms of the disease have been identified.<sup>10,11</sup> In Type I, there is rapidly progressive psychomotor regression with severe neurologic signs and death within the first 6 years of life. In Type 2, the neurologic involvement is milder. There is longer survival, and skin lesions of angiokeratoma corporis diffusum are present.11

In none of the earlier reports has the roentgen features been noted in detail. The purpose of this report is to describe the roentgen findings in 2 new patients with fucosidosis Type 2 and to review the literature concerning the previous 9 reported cases of fucosidosis. The clinical, pathologic and biochemical features of our patients are described in detail in separate reports.10,11

### CLINICAL SUMMARIES

A 4 7/12 year old boy (Case 1, birth date Feb. 15, 1969) and his 9 year old brother (Case II, birth date August 26, 1964) were admitted for evaluation of mental retardation, coarse facies, and skin lesions.

Both parents were of German and Italian extraction. There was no known consanguinity. Each child had been the product of a normal pregnancy and delivery and had shown normal development during the first year of life. Psychomotor regression and facial coarsening became apparent at 18 months of age.

In Case 1, a dilated vessel was noted on the upper gum near the incisors at 6 months of age. In Case II, lesions of angiokeratoma corporis diffusum appeared on the scrotum and phallus at 5 years of age and subsequently spread over

the buttocks, abdomen, and thighs.

On physical examination of Case 1, the height was 97 cm. (third percentile), weight was 19 kg. (30th percentile) and head circumference 50 cm. (40th percentile). The face was coarse, and the teeth were widely spaced. Angiokeratomatous lesions (dilated vessels which did not fade with pressure) were noted on the gums. The skin was thick and subcutaneous vascular markings were prominent, especially on the palms, soles, and thorax. Spasticity, rigidity, and posturing were present. The deep tendon reflexes were increased, and Babinski responses were positive bilaterally. No hepatosplenomegaly or corneal opacities were observed.

On physical examination of Case II, the height was 110 cm. and the weight 22 kg., both below the third percentile. The head circumference was 51 cm. (40th percentile). The face was coarse, and drooling was present. Neurologic findings were similar to those of the younger brother, although in Case II the spas-

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TABLE I

ENZYMES STUDIED IN CULTURED SKIN FIBROBLASTS
AND LYSOSOMAL DISEASES DUE TO DEFICIENCY
OF FACH ENZYME

Enzyme	Disease
Arylsulfatase A	Metachromatic leuko- dystrophy
Arylsulfatase B	Maroteaux-Lamy
Acid Alpha-Glucosidase	Pompe's
Alpha-Galactosidase	Fabry's
Alpha-Iduronidase	Hurler's, Scheie's
Alpha-Fucosidase	Fucosidosis
Alpha-Mannosidase	Mannosidosis
Beta-Galactosidase	Generalized gangliosidosis
Beta-Glucosidase	Gaucher's
Beta-Glucuronidase	Mucopolysaccharidosis VII

ticity, rigidity, and posturing were more severe. The skin was thick, and subcutaneous vascular markings were prominent on the thorax, palms, and soles. Pinhead-sized maculo-papular purplish lesions (angiokeratoma corporis diffusum) covered the external genitalia and were scattered over the abdomen, buttocks, and thighs. There was no hepatosplenomegaly. The corneas were clear.

Routine blood chemical studies were unremarkable in both patients, and neither had mucopolysacchariduria.

Enzymatic findings. Absence of alpha-L-fucosidase activity was demonstrated in cultured skin fibroblasts of both patients. No activity of alpha-L-fucosidase was found in the peripheral leukocytes of Case I, while severe enzymatic deficiency was demonstrated in the leukocytes of Case II. The activities of 9 other lysosomal enzymes, including alpha-galactosidase, were normal. Table I lists the IO enzymes tested. The diseases due to deficiency of each of these enzymes are also noted.

### ROENTGEN FINDINGS

The skeletal findings in our patients may be characterized as a mild dysostosis multiplex with the most striking abnormalities involving the spine, pelvis, and hips. The findings were quite similar in the 2 brothers.

Spine (Fig. 1). In the lumbar region, the vertebral bodies were flattened and variably beaked; wide intervertebral disk

spaces were seen. Most vertebrae were beaked inferiorly while others showed small central anterior projections. Inferior beaking was most marked at L2 in Case I and at L4 in Case II. The lumbar pedicles were elongated. Slight central beaking was seen in the lower thoracic spine, and the odontoid was small in each case.

Pelvis and hips (Fig. 2 and 3). The acetabular roofs were widened, scalloped and sclerotic. Each iliac wing flared immediately above the scalloped acetabulum.

Both patients showed irregularity of the femoral capital epiphyses, and in the older brother extreme flattening was present as well. A wide separation between the acetabular roof and the ossified portion of the femoral capital epiphysis suggested



Fig. 1. Case 1. Roentgenogram of the lumbar spine shows flattening and beaking of vertebral bodies. Inferior beaking is most marked at L2. The pedicles are elongated.



Fig. 2. Case I. Age 4 7/12 years. The acetabula are widened, scalloped, and sclerotic (black arrows). The iliac wings flare immediately above the acetabula (white arrow). Coxa valga is present bilaterally.

the presence of an unusually large cartilaginous component to the femoral head (Fig. 3). Coxa valga was present in both patients.

Upper extremities (Fig. 4; 5; and 6). Both patients had a similar deficiency of the medial margin of the distal radial metaphysis.

Case I showed widening of the shafts of the humerus, radius and ulna, while these bones were normally shaped in his older brother. The metacarpals were slightly widened and had cortical thinning, more pronounced in Case I.

The one finding in the upper extremity which was more marked in the older than

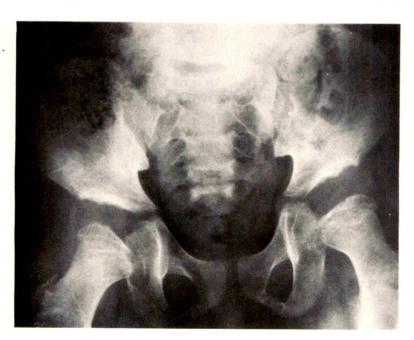


Fig. 3. Case II. Age 9 years. The pelvic configuration is similar to that of Case I. The acetabula are scalloped and sclerotic and the iliac wings low-set and flared. The femoral capital epiphyses are more severely affected than in Case I with marked flattening, more severe on the left than right. A large soft tissue density between each acetabular roof and the ossified portion of the femoral head suggests the presence of a large cartilaginous component to the epiphysis. Coxa valga is present bilaterally.



Fig. 4. Case 1. The humeral shaft is widened.

younger brother was the retardation of bone age. As measured by Greulich and Pyle's standards, the bone age of Case I was 3 6/12 years at a chronologic age of 4 7/12 years. In Case II it was 5 years at a chronologic age of 9 years. Case II had several dense phalangeal epiphyses.

Skull and facial bones (Fig. 7). The overall shape of the skull was unremarkable, but there was diminished aeration of the

paranasal sinuses and mastoids.

The temporomandibular joints, cranial sutures, and sella turcica were normal. Both patients had a prominent notch in the region of the chiasmatic groove which has

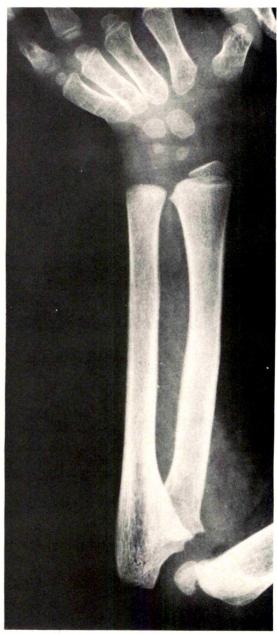


Fig. 5. Case I. Age 4 7/12 years. The radial and ulnar shafts are widened. The medial margin of the metaphysis of the distal radius is deficient. There is a mild degree of expansion and cortical thinning of the metacarpal shafts. The bone age is 3 6/12 years.

been recognized as a developmental variant. In Case 1, the incisor teeth were widely spaced.

Thorax (Fig. 8). The clavicles were widened medially, and the glenoid fossae of the scapulae were flattened. The ribs, heart, and lungs were normal.

Lower extremities. With the exception of the abnormal femoral heads and necks described above, the lower extremities were normal. The feet were not examined.

### DISCUSSION

The combination of vertebral beaking, odontoid hypoplasia, pelvic deformity, widening of the shafts of long bones, and sinus hypoaeration places the skeletal findings of our patients in the category of dysostosis multiplex. While not as severe or as numerous as the abnormalities in Hurler's disease, their presence is suggestive of the diagnosis of a storage disease. Of the mucopolysaccharidoses, the roentgen changes of mucopolysaccharidosis III (Sanfilippo) have the greatest similarities to those of our patients.<sup>12</sup>

The mucolipidosis<sup>17–19</sup> would be considered in any patient with dysostosis multiplex and absence of mucopolysacchariduria. Those mucolipidoses with mild dysostosis multiplex to be included in the differential diagnosis of fucosidosis are mannosidosis, infantile sulfatidosis (Austin type), <sup>17</sup> and mucolipidosis 1. <sup>17</sup>

The main roentgen features of the 9 previous and 2 present cases are summarized in Table II. Cases I-v are classified as fucosidosis, Type I, and cases VI-x as Type 2. Case XI is atypical because of normal intelligence and absence of neurologic signs.

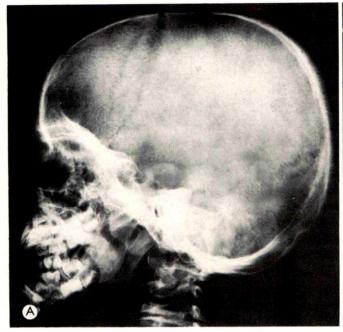
Angiokeratoma corporis diffusum which is characteristic of fucosidosis, Type 2, typically occurs in Fabry's disease. In fucosidosis, the activity of alpha-galactosidase is normal, whereas in Fabry's disease there is deficiency of this enzyme. Thus far, survival to adolescence in fucosidosis has been described only in patients with Type 2 disease. In all of the families



Fig. 6. Case II. Wrist and proximal hand at 9 years of age. The medial margin of the metaphysis of the distal radius is deficient. The development of the ossification centers of the hand and wrist is severely retarded and is similar to that of a 5 year old.

in which there are 2 affected offspring, the skin lesions have been either present or absent in both.

Vertebral abnormalities are mentioned in most of the previous 9 cases. These are not described with uniform terminology, but hypoplasia or vertebral beaking have been specifically mentioned in Cases I, II, III, and v and are present in our cases. Cases IV, VII and XI are stated to have abnormal



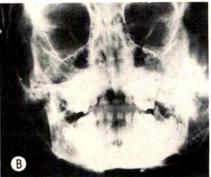


Fig. 7. Case I. (A) Lateral view of the skull and (B) Waters' view of the sinuses. In the lateral projection no mastoid air cells are seen. The odontoid is hypoplastic. In the Waters' view the aeration of the maxillary sinuses is deficient. The incisor teeth are widely spaced.

vertebrae as well. The only published roentgenogram in any patient with fucosidosis is a lateral view of the lumbar spine of Case VII which shows flattening and irregularity of the vertebral bodies. In Case III, "antero-superior beaking" of D4, LI, L2, and L3 was mentioned at 3 3/12 years. Since "antero-superior hypoplasia" of L2 had been described in the same patient at 16 months, it is probable that the

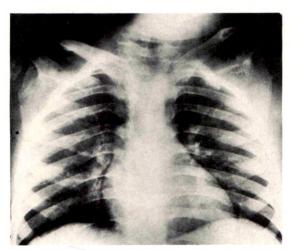


Fig. 8. Case II. Medial widening of the clavicles and flattening of the glenoid fossae are seen. The heart, lungs, and ribs are normal.

"antero-superior beaking" subsequently referred to is actually an antero-superior hypoplasia or inferior beaking.

The epiphyses are not specifically mentioned in most of the cases. Case III is said to have normal extremities. Femoral head flattening was present in Cases VII and VIII and in our cases as well. Case XI is described as "spondyloepiphysealmetaphyseal dysplasia."

Abnormalities of the pelvis are mentioned in Cases IV, VII, and VIII. The pelvis is said to be normal in Case III. Sclerotic acetabular roofs were seen in Case VII as well as in the present cases.

There is reference to the skull in Cases III, IV, and VII. Diminished sinus aeration was seen in Case III as well as in the present 2 cases. The skull of Case IV is said to be similar to that of mucopolysaccharidosis III. A thick skull is described in Case VII.

The discrepancy between skeletal age and chronologic age has been greater in the older patients. Case VII at 17 years of age had a bone age of 10 years. Our Case II at 9 years had a bone age of 5 years. Bone age retardation of between 1 and 1 1/2 years was found in Cases III, VIII and our

TABLE II
SUMMARY OF ROENTGEN FINDINGS IN PREVIOUS AND PRESENT CASES OF FUCOSIDOSIS

Case Number*	Authors	Sex	Description of Roentgen Findings
I. Brother of Case II	Durand <i>et al.</i> <sup>4</sup> 1966	M	At 3 6/12 years Cardiomegaly Inability of gallbladder to concentrate contrast material L2, L3 hypoplastic and beaked
II. Sister of Case 1	Durand <i>et al.</i> <sup>4</sup> 1966	F	At 4 7/12 years Cardiomegaly Normal gallbladder L2, L3 hypoplastic and beaked
III.	Loeb <i>et al</i> . <sup>13</sup> 1969	M	At 16 months Slight dysplasia of antero-superior border of L2
			At 3 3/12 years  Delayed skeletal maturation (bone age=2 years)  Normal bone trabeculation  Large skull with prominent forehead, diminished aeration or sinuses, normal sella with deep anterior pocketing  Slight dorsolumbar kyphosis  Poorly developed, slightly biconvex vertebral bodies with antero-superior beaking of D4, L1-3  Normal pelvis and extremities
IV.	Freitag <i>et al.</i> 6 1971	M	At 2 1/2 years  Mild but definite dysplastic changes of skull, spine, pelvis, hand, similar to mucopolysaccharidosis III
v.	Matsuda <i>et al.</i> <sup>14</sup> 1973	F	At 4 2/12 years Delayed skeletal maturation Hypoplastic vertebral bodies of L1, L2, L3
VI.	Patel <i>et al</i> . <sup>15</sup> 1972	M	At 20 years  No skeletal abnormalities compatible with mucopolysaccharidosis
VII. Brother of Case viii	Gatti <i>et al.</i> <sup>7</sup> 1973	M	At 17 years Thick skull Generalized flattening and irregularity of vertebral bodies Intervertebral disk calcification between D11 and D12 Pectus carinatum Spatulation of ribs Shallow acetabular cavities with sclerotic roofs Iliac bodies constricted Femoral capital epiphyses sclerotic and partially destroyed Femoral necks enlarged and shortened Metacarpals hypoplastic Radio-ulnar epiphyses dystrophic Bone age=10 years
VIII. Sister of Case vii	Gatti et al. <sup>7</sup> 1973 Borrone et al. <sup>1</sup> 1974	F	At 5 years  Expansion and atrophy of cortex at lower end of femur with dilatation of medullary cavity  Femoral head flattened Acetabulum deformed Osseous development retarded by 1 1/2 years Cardiomegaly
IX. Brother of Case x	Present report Case 1	M	At 47/12 years Mild dysostosis multiplex See text
X. Brother of Case IX	Present report Case II	M	At 9 years Mild dysostosis multiplex See text
XI.	Shafer <i>et al</i> . <sup>16</sup> 1971	M	At 9 years Spondyloepiphyseometaphyseal dysplasia

<sup>\*</sup> Cases 1-v are examples of fucosidosis Type 1. Cases vi-x are examples of fucosidosis Type 2. Case xi is clinically atypical.

Case I, all of whom had chronologic ages between 3 and 5 years.

There is insufficient information available at present to detect any consistent differences in roentgen findings between Type I and Type 2 because of lack of detailed roentgenographic study of previous patients with fucosidosis. It is apparent from the descriptive data available, however, that there is considerable variability in roentgen findings even among the patients of the same clinical type.

## SUMMARY

The roentgen findings are described in 2 siblings with fucosidosis Type 2.

They have mild dysostosis multiplex with predominant involvement of the spine, pelvis, and femoral capital epiphyses.

The roentgen descriptions of the previously reported cases are reviewed.

Based on the descriptive data currently available, there are no consistent differences which would permit the distinction of fucosidosis Type I from Type 2 on roentgen grounds.

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## BONE SCANNING—OSTEOGENIC SARCOMA\*

## CORRELATION WITH SURGICAL PATHOLOGY

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IN the management of osteogenic sarcoma, a preoperative determination of the extent of the tumor is desirable.

A prospective study was designed to evaluate the degree of regional tumor extension, correlating routine roentgenographic studies, isotope scans, and the surgical pathology.

## MATERIAL AND METHOD

During a period of 13 months, all patients who were referred to New York University Medical Center with a presumed diagnosis of primary osteosarcoma were studied by radioisotopic bone scans as well as routine roentgenographic techniques. There were 13 patients (ages 10-31), who had biopsy proven osteogenic sarcomas. These tumors were all in the lower extremities: 9 in the distal femur; 3 in the proximal tibia; and I in the proximal fibula (Table 1). One of the subjects had a primary parosteal lesion which had invaded the adjacent femur. This case was included because parosteal lesions which breech the cortex probably behave aggressively.18 One additional patient, aged 53, was eliminated from the study because of co-existing Paget's disease.

The scan examinations were designed specifically for (1) evaluation of contiguous tumor extension and (2) the early detection of pulmonary metastases. Complete scans were obtained on both lower extremities, the pelvis, and chest. Scannings were performed with a maximum dose of 10 mc of Tc<sup>99m</sup> polyphosphate or 15 mc of Tc<sup>99m</sup> diphosphonate. The individual dose was adjusted to the patient's weight.

In 2 cases a marrow scan obtained with Tc<sup>99m</sup> sulfur colloid was added to the diagnostic work-up.

The routine roentgenographic studies included chest roentgenograms, and a skeletal survey which included all of the long bones. The results were then correlated with the surgical pathology as well as the clinical follow-up.

#### RESULTS

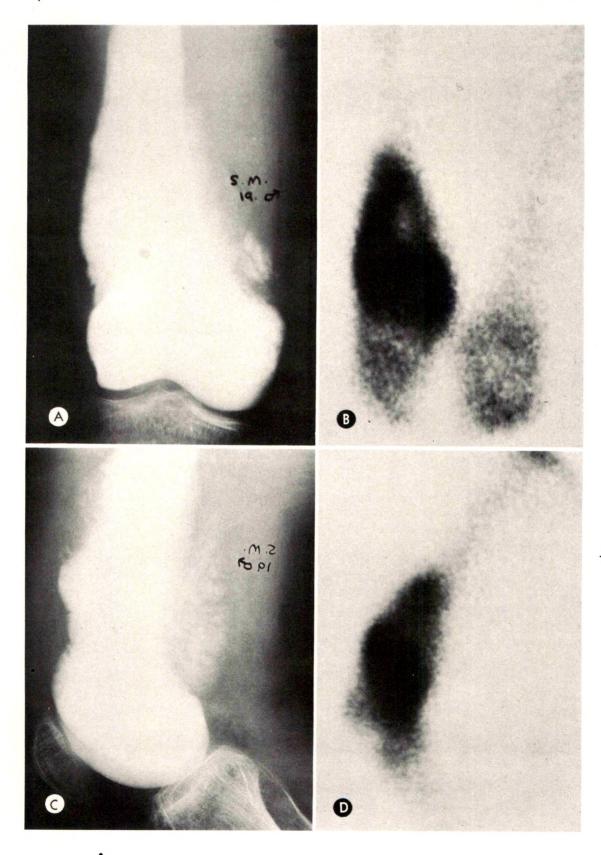
The intention of the study was to determine if isotopic bone scanning might be more sensitive than routine roentgen examination in demonstrating local extension of the tumor. The roentgenogram, scan, and gross specimen of each subject were compared by visual examination for extension

Patient	Age	Site	Sex
1. D.S.	16	R distal femur	Male
2. R.F.	16	L proximal tibia	Female
3. L.L.	13	L distal femur	Female
4. R.Z.	21	R distal femur	Male
5. R.D.	12	R proximal tibia	Male
6. S.M.	19	R distal femur	Male
7. W.J.	13	L distal femur	Male
8. M.S.	10	R distal femur	Male
o. D.P.*	31	R distal femur	Female
10. W.O.	26	R distal femur	Male
11. D.D.	15	L proximal fibula	Male
12. J.S.	17	L proximal tibia	Male
13. A.S.	17	L distal femur	Male

The male predominance and age distribution of the 13 subjects correspond to the incidences reported in larger review series of patients with osteosarcomas. 10.11 The \* denotes the single patient with a parosteal lesion.

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<sup>\*</sup> Presented at the Seventy-fifth Annual Meeting of the American Roentgen Ray Society, San Francisco, California, September 24-27, 1974.



along the shaft of the bone. The magnification factors of the roentgenograms and scintillation scans could not be accurately determined, so that precise correlation of the size would not have been valid.

In 12 of 13 cases the area of abnormal radioisotopic uptake corresponded to the extent of roentgenographic changes, but did not exceed them (Fig. 1). In those cases operated on, the tumor involvement in the gross specimens correlated well with the areas of abnormality seen by both diagnostic imaging modalities. The 2 or more frozen sections obtained from each marrow space proximal to the tumors were negative in all of these cases. The single exception was a 21 year old male with a primary tumor of the right distal femur. The scan obtained on the latter patient demonstrated slight increase in isotopic uptake throughout the shaft of the femur proximal to the tumor (Fig. 2). The plain film roentgenographic examination did not demonstrate abnormalities beyond the distal metaphysis. Pathologic examination did not reveal intramedullary tumor spread. However, this particular tumor was associated with marrow necrosis, giant cell infiltration, and granulation tissue. The significance of this histologic finding is not clear.

In addition to the dense areas of abnormal uptake which corresponded to the tumors, 10 patients exhibited a relative increase in the normal isotope uptake at the ends of the long bones of the affected extremity (Fig. 3). Several of these areas were included in the surgical specimens and failed to demonstrate tumor cells or any other histologic abnormality. This observation will be discussed in a later publication.

The marrow scans obtained on 2 patients were unsuccessful in demonstrating abnormalities, due to insufficient marrow

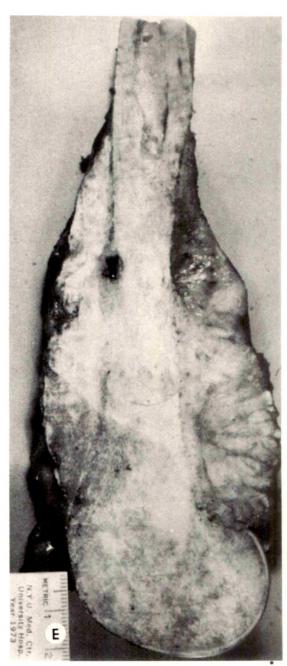


Fig. 1. (E) Surgical specimen also confirms the good correlation.

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Fig. 1. (A) Roentgenogram of a 19 year old male with a primary osteosarcoma of the right distal femur. (B) The anterior scan shows no appreciable difference in the extent of local tumor spread. Lateral views of the (C) roentgenogram, and (D) scan, confirm the good correlation.

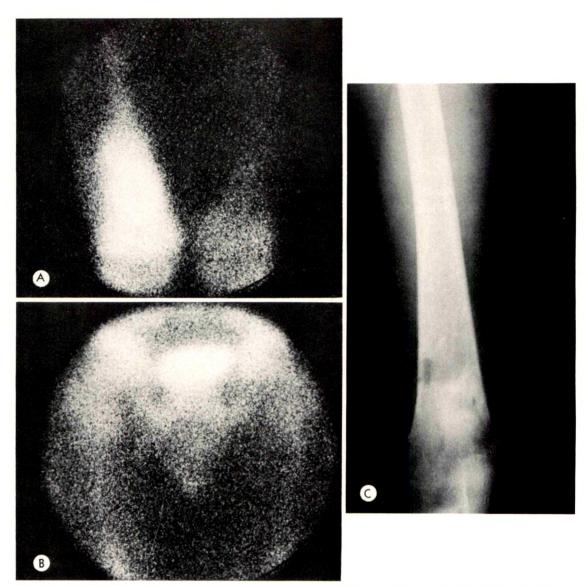


Fig. 2. (A and B) The scans obtained on this 21 year old male with an osteosarcoma of the right distal femur demonstrated a slight increase in activity throughout the shaft proximal to the tumor. (C) The roent-genogram shows no abnormalities beyond the distal metaphysis.

activity in the long bones of individuals in the second decade of life.

Twelve of 13 patients were treated surgically. The 13th case was found, on both scan and roentgenogram, to have a secondary lesion in the 10th thoracic vertebra and was treated with radiation therapy alone. To date there have been 3 local recurrences (Fig. 4), 2 of which presented simultaneously with hematogeneous lung metastases. They occurred 4–9 months

after the initial surgical procedure; 3 other patients have returned with pulmonary metastases and 1 of these has died; 6 others are tumor free, with the longest follow-up being 13 months after the initial surgery.

## DISCUSSION

At the time of diagnosis, most, if not all, osteosarcomas have penetrated the cortex and invaded the adjacent soft tissues.<sup>3,18</sup> Malignant bone forming tumors also spread

via the medullary cavity and the presence of unappreciated intramedullary extension has traditionally been cited as pathologic evidence for the necessity of amputation above the involved bone. The latter concept originated in 1879 in a publication by Gross pointing out that "sarcomatous tissue may exist in the medullary canal at some distance from the original growth."20 In 1949, Upshaw et al.20 challenged the concept of discontinuous areas of tumor spread. These authors in a study of 50 surgical specimens found no "skip areas" of tumor and established: that involvement of the medullary cavity occurred only by direct extension; that it was continuous, and its extent was unrelated to vascular invasion and distant metastases. Subsequent large review articles about osteosarcoma have substantiated the continuous nature of the local involvement3,18 and in 1974 a series of 20 amputation specimens reviewed specifically for intramedullary spread revealed no discontinuous areas of tumor.10

The incidence of extensive involvement of the marrow has also been contested since the early pathologic studies of osteosarcoma. Upshaw et al.20 found microscopic extension to be less than 3 inches in 88 per cent of cases, but their series did include several examples of tumor which involved the entire marrow. Dahlin,3 in a series including malignancies which "spread surprising distances," emphasized that "most tumors do not spread in the marrow beyond their gross extraosseous limits." The experience at the Armed Forces Institute of Pathology confirms that advanced intramedullary spread is rare,18 and a recent study by Lewis and Lotz10 found no microscopic extension beyond the gross tumor margin.

In view of the latter material, which established the intramedullary spread of osteosarcoma to be contiguous and only rarely extensive, it might be appropriate to perform less radical extirpative procedures. Several surgical series have reported the same or better survivals in



Fig. 2. (D) The surgical specimen did not reveal intramedullary tumor spread beyond the gross margins of the lesion; however, there were areas of fat necrosis in the marrow.

patients treated with transmedullary amputation compared to disarticulation or resection above the tumor bearing bone. 6,11,16 However, preoperative evaluation of the intramedullary extension is desirable in order to determine the level of resection. Since there is some controversy regarding the accuracy of the roentgenogram in determining extent of the tumor, we embarked on this study with the correllated use of isotopic scans. 3,10,16,18,20

Until recently bone seeking radioisotopes have not been extensively used for the diagnosis of primary bone lesions in children and young adults, due to the high radiation doses. With the advent of short lived radioisotopes such as Tc<sup>99m</sup> labeled compounds this objection has been negated.

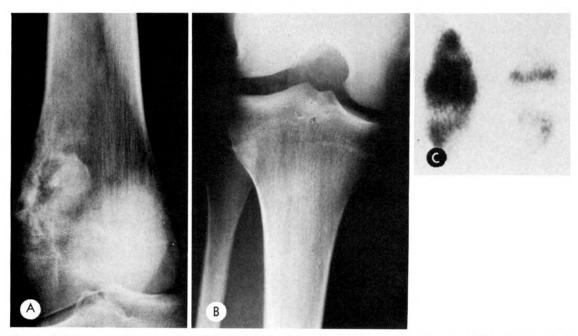


Fig. 3. (A) Primary osteosarcoma of the right distal femur. (B) The roentgenogram of the adjacent tibia is unremarkable. (C) In addition to the dense area of abnormal isotopic uptake, corresponding to the tumor, the scan shows a definite asymmetry in the normal areas of activity at the proximal ends of the tibiae.

The success of bone scanning in demonstrating metastatic lesions prior to the roentgenogram or clinical findings has been widely established.<sup>2,4,13,14,21</sup> The greater sensitivity of scintillation scanning is related to the fact that visualization depends on the rate of mineral uptake, unlike standard roentgenograms that reflect total bone mass and must be reduced by a factor of at least 30 per cent.<sup>2,5,13,21</sup> It was established early that scanning was not a reliable means of differentiating benign from malignant lesions.13,21 It has been stated in several publications that isotopic studies may be helpful in detecting the extent of local spread of osteosarcoma. 1,12,19,21 In a survey of the literature we were unable to find a controlled study that proved this proposition. Autoradiographic studies performed on postoperative specimens of osteosarcomas have demonstrated that localization of strontium 85 correlated best with cellularity rather than the greatest density of tumor bone. Thus, isotopic uptake was least in areas of necrosis, totally undifferentiated tumor, and more mature

tumor bone. Bone seeking isotopes were also found to concentrate selectively in some pulmonary lesions of osteosarcoma. 14 making it possible to simultaneously assess the 2 commonest sites of hematogeneous spread: the lungs and bone. 15,18 The detection of a second osseous lesion in 1 of our cases did change the clinical management and the patient received radiation therapy rather than ablative surgery; however, both lesions were also appreciated on roentgenographic examination. Contrary to the brief references concerning the value of scanning in evaluating local spread, our experience indicated that the abnormal area on the scan corresponded to, but did not exceed, the roentgen changes. None of our subjects pathologically exhibited extensive intramedullary spread and perhaps scanning may be useful in detecting preoperatively the rare osteosarcoma which involves the marrow more extensively. since I case did reveal subtle changes associated with marrow necrosis.

Although both the scan and roentgenogram correlated well and indicated no

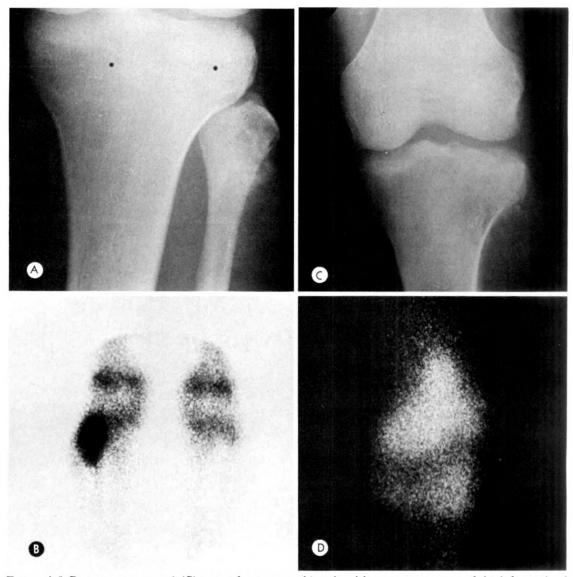


Fig. 4. (A) Roentgenogram and (B) scan of a 14 year old male with an osteosarcoma of the left proximal fibula. Nine months postoperatively he was readmitted with a soft tissue recurrence at the site of resection. Secondary involvement of the adjacent tibia was demonstrated on both (C) the roentgenogram and (D) the scan.

tumor extension beyond the area of surgical resection, 3 of our cases were complicated by local recurrences. In all of the latter patients frozen sections obtained from the operative field were negative for tumor cells. This phenomenon has been noted in several other series of osteosarcoma with local recurrence rates reported up to 20 per cent.<sup>15,16,19</sup> Two possibilities are present. Some tumor cells may indeed exist in the marrow proximal to the tumor

with none of the preoperative or operative studies being sensitive enough to demonstrate their presence. 6.8,19 However, it is also possible that the surgical site represents an area which is sensitive to hematogeneous seeding. The latter theory is supported by the high frequency of simultaneous presentation of pulmonary metastases, a phenomenon noted in 2 of our own cases. Local recurrences, although they produce significant morbidity, do not pre-

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clude long term survival.<sup>16,19</sup> The relationship between local recurrences and surgical approach is extremely difficult to exaluate because therapy varied widely among patients, even in the same series.<sup>3,7,9,15,17,19,22</sup> This is especially true in publications from England where radiation therapy is the primary mode of treatment and surgery is reserved for patients with intractable pain or those who have no evidence of disseminated disease after several months of observation.<sup>9,19</sup>

## SUMMARY

This study was designed to evaluate the role of isotopic scanning in determining the local extension of osteosarcoma. During the period of the study, 13 patients with biopsy proven osteosarcomas were evaluated.

The results indicated that in no case did the isotope scan demonstrate greater intramedullary extension of tumor than the routine roentgenographic examination.

In addition, despite good correlation between the roentgenogram, scan, and histologic evaluation of tumor extent, all of which showed no evidence of malignancy near the area of surgery, there have been to date 3 local recurrences.

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## ARTHROGRAPHY IN OSTEOARTHRITIS OF THE HIP\*

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Since arthrography was first done by Shievers in 1937 for congenital dislocation of the hip, many reports have appeared on this subject. 1-8,10,14 To date, this method has become an indispensable test in the treatment of congenital dislocation of the hip in infants and children, especially regarding irreducible dislocation. To measure the cartilaginous acetabular angle in acetabular dysplasia, arthrography is the procedure of choice.

In general, when treating osteoarthritis of the hip in which acetabular dysplasia accounts for more than 80 per cent of the change, arthrography has rarely been used in Japan. However, since 1968, in the Department of Orthopaedic Surgery, Kyoto University Hospital, preoperative arthrography has usually been carried out for operative management of osteoarthritis of the hip, and certain significant factors received attention.

## METHOD

Urografin 76 is used as the contrast material. To ensure that the injection does indeed enter the joint, the procedure is carried out under fluoroscopy. The needle is inserted from the anterior side of the greater trochanter and advanced straight, until strong resistance is felt immediately below the femoral head. Even if it feels that the tip of the needle has come in contact with bone in the joint cavity, it has frequently been found that the tip has not yet reached the joint cavity, due to the capsular thickening. Despite a strong resistance which may at first be encountered, the needle should be advanced further until a second strong resistance is felt. When the needle cannot be advanced any further, a total amount of 3-5 ml. of contrast medium is injected, after determining that the needle tip is indeed in the capsule. Injection of more than 4 ml. frequently causes intense pain due to a rise of intracapsular pressure in the osteoarthritic joint. The intense pain as the result of the injection is usually transient, passing with the absorption of the contrast medium; however, the duration of the pain is subject to individual variation, and relief occurs within 5 minutes at the earliest, to 2 hours at the latest.

## ARTHROGRAPHIC FINDINGS

Figure 1, A and B, shows the arthrographic findings in osteoarthritis of the hip of an adult and is almost identical with the arthrographic findings in infants and children. Cartilages of acetabular roof and femoral head, labrum, lateral puddle of contrast medium, orbicular zone, ring of contrast medium around the femoral neck, and puddle of contrast medium medial and lateral to the transverse ligament are observed in arthrograms of the hip. Puddle of contrast medium medial and lateral to the transverse ligament forms median pooling as a whole.

Median pooling. In prearthrosis as well as in the initial and advanced stages of arthrosis, as graded by the Japanese Orthopaedic Association, median pooling can be distinctly noted. In the terminal stage of arthrosis, however, despite lateral deviation of the femoral head, a marked retention is not always found due to the presence of an osteophyte in the form of capital drop and double floor from acetabular bottom margin. Median pooling usually tends to decrease by abduction of the hip joint and increase by adduction (Fig. 2, A and B). According to the degree of centripetal position of the head to the acetabular socket, the state of pooling changes. When the opaque medium of median pooling shifts

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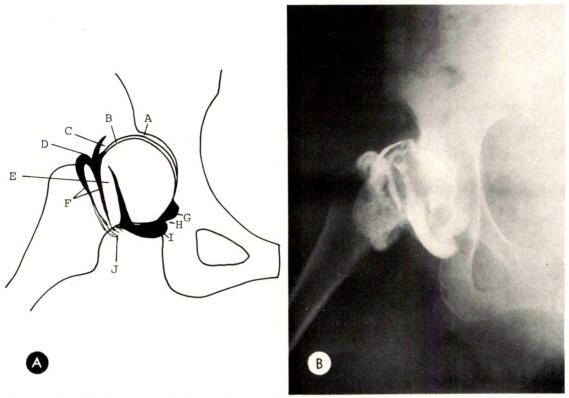


Fig. 1. (A and B) Schematic drawing and an arthrogram of initial stage of osteoarthritis. A=cartilage of acetabular roof; B=cartilage of femoral head; C=labrum; D=lateral pooling of contrast medium; E=orbicular zone; F=ring of contrast medium around the femoral neck; G=puddle of contrast medium on the medial side of the transverse ligament; H=transverse ligament; I=puddle of contrast medium on the lateral side of the transverse ligament; G and I form median pooling; J=subcapital puddle of contrast medium.

laterally due to abduction of the hip joint, the fit of the joint also improves due to abduction, in many instances indicating varus osteotomy. On the other hand, median pooling decreases in some cases due to adduction. At this time, congruity frequently improves by adduction, thus providing an indication for valgus osteotomy. Arthrography should be carried out to demonstrate the state of median pooling, when it is difficult to determine the type of osteotomy by congruity based on functional roentgen studies alone.

Joint cartilage. In the prearthrosis and initial stage of arthrosis, articular cartilage is sufficiently maintained, as is evident from arthrographic findings. This is well demonstrated in this joint space in conventional roentgenograms. In the advanced stage of

arthrosis, cartilage degenerates and its thickness decreases. Osteotomy is usually done at this stage. Even when the joint space at the weight bearing portion has already disappeared, the degree of wear of the joint cartilage at the adjacent portion or the potential weight bearing area should be known before surgery, in order to determine the indications for this repair and the type of surgery required. This can be better accomplished by arthrography (Fig. 3). In case of adduction contracture of the hip joint, functional roentgenography is impossible and arthrography reveals the irregularity of the articular cartilage not only on the weight bearing portion, but also on the adjacent part. When the cartilage of the adjacent part is intact, regeneration of the cartilage will usually take place after

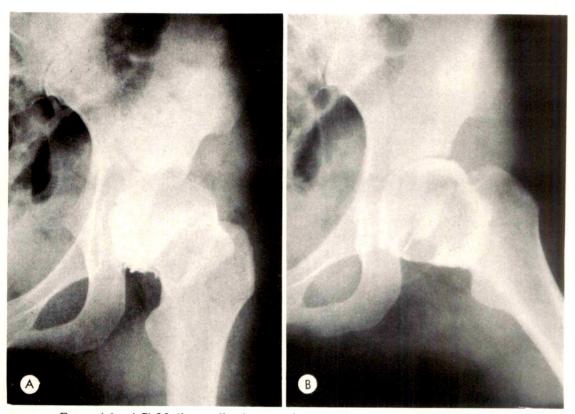


Fig. 2. (A and B) Median pooling increases by adduction, and decreases by abduction.

osteotomy. In cases with extensive narrowing of the joint space of the weight bearing area, resulting in an exposure of subchondral bone, regeneration of cartilage does not usually occur, and arthroplasty or arthrodesis is the surgery of choice.

Indication for osteotomy on the basis of roentgen findings is as follows: (I) when the congruity of the joint is improved by abduction or adduction of the hip joint as viewed on conventional roentgenograms; (2) when arthrography reveals change of median pooling by abduction or adduction of the hip joint, and also shows intact cartilage of the new weight bearing portion after osteotomy.

Acetabular labrum. Presence of an acetabular labrum in arthrography is similar to that observed in infants and small children. While this procedure is of significance in pediatrics for the measurement of cartilaginous acetabular angle and in order to

decide whether or not a factor disturbing reduction is present, the significance of labrum in osteoarthritis of the hip simply consists of the length (Fig. 4). When acetabuloplasty is carried out for prearthrosis or initial stage of arthrosis, the length of the original acetabular roof to the end of the acetabular labrum is important. When a new acetabular roof is prepared beyond the length of the acetabular labrum, pressure against the new acetabulum is different either in the presence and absence of acetabular labrum, and cystic change or occasionally fracture-like changes occur at the edge. Resection of the acetabular labrum would result in disappearance of the buffer mechanism at this site and the prepared acetabular roof may compress the femoral head to accelerate changes of degenerative arthritis of the hip. Resection of the acetabular labrum should therefore be avoided.



Fig. 3. Disappearance of joint cartilage is present at weight bearing portion, but can also be found in other portions.

## DISCUSSION

To evaluate the symptoms of osteoarthritis of the hip and make a decision as to the adequate operative procedure required, the clinical picture such as pain, ability to walk, joint mobility, activities of daily living as well as the roentgenograms should be studied. 9,11,13 It is sometimes difficult to evaluate the disease based on clinical and roentgen studies alone, and at this time the operative procedure itself has to be carefully considered. Under such circumstances, an auxiliary method such as clearance of radioisotopes from the joint should be used. 12 As a rule, arthrography is carried out in patients hospitalized for surgery. In the past, arthrography was not considered to be a necessary preoperative procedure in osteoarthritis of the hip, and preoperative investigation did not include

it. The reasons were: (1) definite findings, when utilizing arthrography as applied to osteoarthritis, are lacking, compared to arthrography used for congenital dislocation of the hip in pediatrics; (2) decision for an operative procedure can often be made with relative accuracy based on conventional and functional roentgen studies. In many patients with osteoarthritis of the hip, however, there are instances when it is difficult to decide on the operative procedure based on these findings alone, and then arthrography as an auxiliary procedure is carried out. When acetabuloplasty is done for prearthrosis and the initial stage of arthrosis, and osteotomy for initial or advanced stages of arthrosis, arthrographic findings are indeed of great value. In the terminal stage, where there is extensive loss of joint space and joint cartilage as observed on conventional roentgenograms,



Fig. 4. Acetabular labrum with acetabular dysplasia.

The new acetabular roof should be made so as to cover the acetabular labrum.

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arthrography is not always done. In patients over 50 years of age with a picture of terminal stage arthrosis, or those over 50 years of age with advanced stage of arthrosis plus intense pain, marked decrease of the range of motion and giant cystic formation in the femoral head or acetabulum, total hip prosthetic replacement is indicated. Arthrography is eliminated to preclude any additional risk of infection—the greatest complication of total hip replacement.

## CONCLUSION

Arthrography is usually done on patients hospitalized for surgery to remedy osteoarthritis of the hip.

While the arthrographic findings in osteoarthritis of the hip are not so significant as in congenital dislocation of the hip of infants and children, nevertheless this is a useful method since arthrographic findings vary at each stage and can be compared with the clinical picture and conventional roentgen findings. Thus arthrography is useful to assess the total disease picture and to decide on the operative procedure required.

În patients requiring osteotomy or acetabuloplasty, this method is of great significance and has proved entirely adequate.

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## OCCULT CENTRAL FRACTURES OF THE **ACETABULUM\***

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HE roentgenographic assessment of pelvic trauma frequently consists of only a single anteroposterior roentgenogram of the pelvis. Most pelvic fractures are readily apparent in this projection.

We have recently encountered 4 cases of occult central acetabular fractures. These particular fractures may be quite difficult, or even impossible to visualize on the anteroposterior roentgenogram.<sup>3,4</sup> The diagnoses in this series were delayed for periods varying from 6 hours to 9 days until roentgenograms of the pelvis were obtained in the posterior oblique projection in 3 cases and until disclosed by tomography in the fourth case.

## PRESENT SERIES

There were 2 males and 2 females ranging in age from 23 years to 57 years. All 4 fractures involved the right hip—a finding of questionable significance. Two were the result of falls and 2 occurred in automobile accidents. Both of the latter patients were passengers in the front seat. The significant clinical and roentgenographic findings are summarized in Table 1.

## ANATOMY

(Fig. 1, A and B)

The acetabulum is a concavity located in the apex of an arch formed by 2 columns of bone.3 The posterior or ilioischial column descends caudad to the ischial tuberosity. This column is composed of the vertical portion of the ischium and the immediately adjacent portion of the ilium. On the anterolateral surface of the column lies the

posterior articular surface of the acetabulum and the posterior acetabular rim. The medial surface of this column consists of a broad, smooth plate of bone termed the quadrilateral surface. The most medial and posterior corner of the quadrilateral surface is the ischial spine.

The anterior or iliopubic column runs obliquely downward, inward, and anteriorly making an angle of approximately 60° with the posterior column. The anterior column consists of a short segment of the ilium and the pubis. On its posterolateral surface is the anterior portion of the articular surface of the acetabulum and the anterior acetabular rim.

The acetabulum is marginated by a thick ledge of bone, the condyloid labrum. This forms a 320° arc about the acetabulum. It is incomplete only in the anterior and inferior segment. This is the acetabular notch. The acetabular notch is contiguous with the thin bone of the centrum of the acetabulum, the acetabular fossa. The medial surface of the acetabular fossa is contained within the quadrilateral surface.

Roentgenographically, 6 anatomic landmarks are seen on the anteroposterior view of the pelvis<sup>3</sup> (Fig. 2). The arcuate line or iliopubic line begins at the sciatic notch and extends downward to the pubic tubercle. A break in this line indicates fracture of the iliopubic column. The ilioischial line is formed by the posterior quadrilateral surface of the iliac bone and a break in this line indicates fracture of the ilioischial column. The roentgenographic u is composed of the anterior and inferior portion of the acetabu-

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Table I
SUMMARY OF CLINICAL AND ROENTGENOGRAPHIC FINDINGS

Occult Central Fractures of the Acetabulum

Patient	Age	Sex	Side	Cause of Injury	Obturator Internus Sign	Vew Demonstrating Fracture
I. EO	49	M	Rt.	fall		posterior oblique
II. RW	57	M	Rt.	fall		posterior oblique
III. LL	23	F	Rt.	automobile accident		anteroposterior tomogram
IV. AM	52	F	Rt.	automobile accident		posterior oblique

lar fossa and the adjacent margin of the quadrilateral surface of the iliac bone. The ilioischial line either intersects or is tangential to the roentgenographic u. Other landmarks of interest are the roof and the anterior and posterior lips of the acetabulum.

## MECHANISM OF INJURY

Central acetabular fractures occur as a result of a severe blow to or a fall upon the greater trochanter. This force is transmitted through the femoral neck and head onto the acetabulum creating a fracture. Acetabular fractures have been described and classified by Judet et al., and Eichenholtz and Stark. The position and course of the fracture lines were the same in each of our cases extending diagonally from the acetabular notch, located anteriorly and inferiorly, across the acetabular fossa to the posterior and superior aspect of the acetabulum. The fractures thus involved the thinnest bone of the acetabulum.

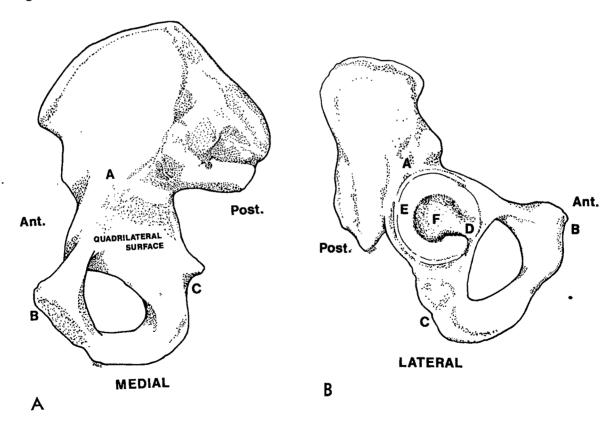


Fig. 1. Innominate bone. (A) Medial view. (B) Lateral view. A to B represents the iliopubic column. A to C represents the ilioischial column. D, the acetabular notch. E, the condyloid labrum. F, the acetabular fossa.

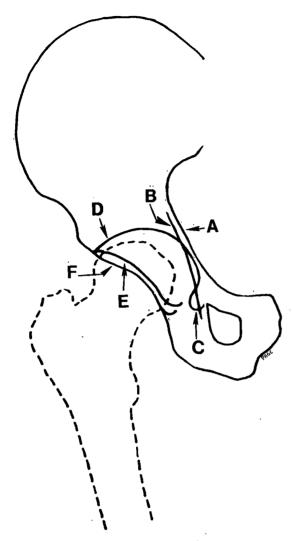


Fig. 2. Roentgenographic landmarks. A, the arcuate (iliopubic) line. B, the ilioischial line. C, the roentgenographic u. D, the acetabular roof. E, the anterior lip of the acetabulum. F, the posterior lip of the acetabulum.

## ROENTGENOGRAPHIC DIAGNOSIS

The history of a fall upon or blow to the greater trochanter and subsequent pain in the hip and inability or refusal to bear weight upon the affected extremity had suggested the presence of a fracture of the proximal femur involving either the head, neck, or trochanters. Roentgenograms of the hip were obtained to substantiate this clinical impression and were unrevealing; the femur was intact. The roentgenograms included an anteroposterior view of the pelvis or hip, a frog-leg projection, and

groin lateral view of the hip. The acetabulum was projected identically on both the anteroposterior and frog-leg views. The undisplaced central fractures of the acetabulum in this series were not apparent in either the anteroposterior (Fig. 3, A and B; 4A; 5, A and B; and 6A) or lateral projections.

The persistence of symptoms led to further evaluation including some combination of fluoroscopy, tomography, and oblique views of the pelvis. The fracture was consistently identified in the 35° to 45° posterior oblique projection (Fig. 3C; 4B; and 6B). Tomography was obtained in 2 cases. It successfully demonstrated the fracture in 1 (Fig. 5B).

The fracture line underlies the origin of the obturator internus muscle on the quadrilateral surface of the ischium. A hematoma or swelling of this muscle was evident in 2 of our cases. This served as the only clue to the underlying injury in the anteroposterior projection (Fig. 3, A and B; and AA).

The fractures in the present series involved bone within the quadrilateral surface described above (Fig. 1, A and B). This plate of bone lies in an anteroposterior plane and is, therefore, parallel to the central beam when an anteroposterior roentgenogram is obtained. On the roentgenogram in this projection the quadrilateral surface is seen on edge as the ilioischial line (Fig. 2; 3, A and B; 4A; 5A; and 6A). In the absence of displacement, it is, therefore, unlikely that fractures of the quadrilateral surface will be evident on the anteroposterior roentgenogram. (This situation is analogous to the inability of visualizing linear, non-depressed lateral skull fractures on the anteroposterior roentgenograms of the skull.) In the lateral projection, although the quadrilateral surface is seen en face, there is superimposition of the opposite side and considerable scattered radiation from the thickness of the body part. The resultant film detail is insufficient to visualize the fracture. When the pelvis is placed in the posterior oblique projection, although the dependent quadrilateral sur-

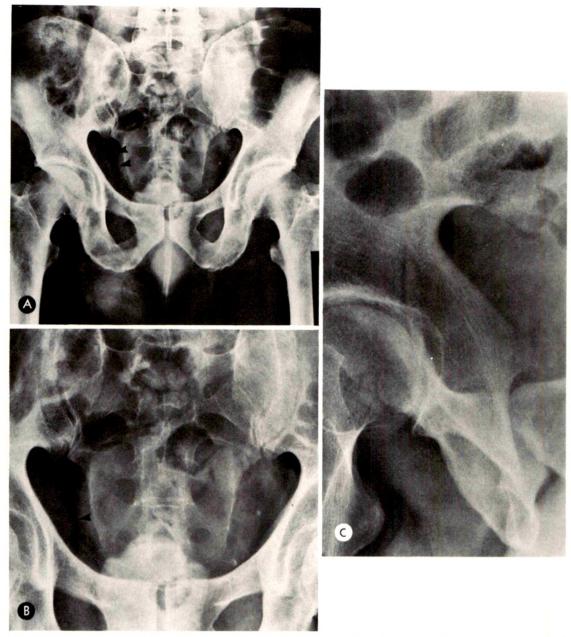


Fig. 3. Case I. (A and B) Anteroposterior view of the pelvis. Obturator internus sign positive (arrowheads). Arcuate and ilioischial lines are normal. Roentgenographic u is normal. (C) Posterior oblique view. Fracture extending from acetabular notch through quadrilateral surface.

face is seen only partially *en face*, it is free of overlying structures and fractures may be visualized.

## DISCUSSION

A single anteroposterior view of the pelvis does not permit an accurate appraisal of the extent or location of the

pelvic fractures. As is shown by the present series, fractures of the acetabulum may not even be visualized in this view. <sup>5,6</sup> In a review of fractures involving the floor of the acetabulum, Pearson and Hagadon found that 29 per cent of such fractures were not apparent on the initial roentgenograms. Our experience would suggest that this

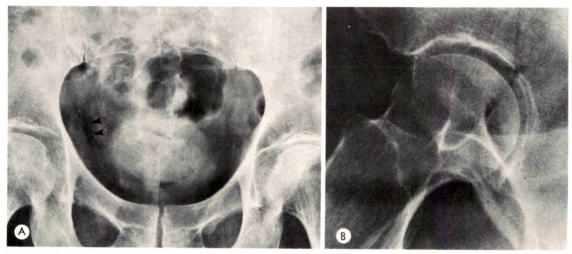


Fig. 4. Case II. (A) Anteroposterior view of the pelvis. Obturator internus sign positive (arrowheads). Arcuate and ilioischial lines are normal. Roentgenographic u is normal. (B) Posterior oblique view. Fracture present extending from acetabular notch through quadrilateral surface.

percentage could have been considerably reduced by obtaining posterior oblique views of the side in question. Knight and Smith<sup>4</sup> have stated that in theory, oblique and lateral roentgenograms of the pelvis should be obtained in the evaluation of pelvic trauma, but in practice, severe pain and discomfort frequently preclude the necessary turning of the patient. In any case, when the anteroposterior view of the

pelvis and multiple views of the hip are unrevealing, every effort should be made to obtain the appropriate posterior oblique view of the pelvis in an attempt to disclose otherwise occult fractures of the acetabulum. Consideration should be given to the practicality and advantages of obtaining the frog-leg view of the hip with the patient in the posterior oblique position. Although this has the disadvantage of re-

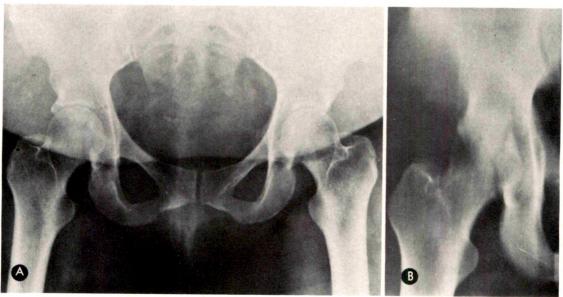


Fig. 5. Case III. (A) Anteroposterior view of the pelvis. Vague radiolucency seen in right acetabular region.
(B) Anteroposterior tomogram. Fracture present extending through the quadrilateral surface.

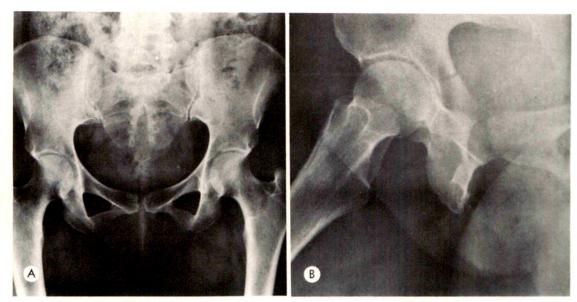


Fig. 6. Case iv. (A) Anteroposterior view of the pelvis. Vague radiolucency seen in right acetabular region.
(B) Posterior oblique view. Fracture present extending through the quadrilateral surface.

quiring a second exposure for the demonstration of both sides, it offers the advantage of a more thorough and accurate assessment of the acetabulum without limiting the evaluation of the proximal femur.

The treatment of undisplaced central acetabular fractures is usually a short period of traction, approximately I week, followed by 6 to 8 weeks of non-weight bearing.<sup>1,2,4</sup> The results are almost uniformly satisfactory and delayed complications, *i.e.*, degenerative arthritis, are rare.

## SUMMARY

Four cases of occult central acetabular fractures are presented.

The oblique plane of the fracture line and the lack of displacement of the fracture fragments made the fractures difficult or impossible to visualize in the anteroposterior projection. The posterior oblique projection placed the fracture line perpendicular to the x-ray beam and, therefore, evident on the resultant roentgenogram. In the 3 cases in which this view was obtained, the fracture was disclosed. In the fourth case the fracture was demonstrated by tomography.

In order to improve the roentgenographic assessment of pelvic trauma, consideration should be given to obtaining posterior oblique views of the pelvis as a matter of routine.

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## VERTICAL FRACTURE OF THE SACRAL ALA\*

## SIGNIFICANCE OF NON-CONTINUITY OF THE ANTERIOR SUPERIOR SACRAL FORAMINAL LINE

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THE reported incidence of fracture of the sacrum in association with fracture of the pelvic ring ranges from 4 to 74 per cent.<sup>1,3</sup> The majority of these are vertical fractures of the sacral ala involving the first and second sacral foramina. An excellent assessment of sacral fractures by Bonnin emphasized the neurologic consequences of such a fracture.<sup>1</sup> Reviews by Pelletier,<sup>5</sup> and by Dunn and Morris<sup>2</sup> analyzed the bio-mechanics of pelvic fractures.

In practice many of these fractures are missed. Reports conflict in the literature as to the proper roentgenographic technique to promote their detection. The author of an acknowledged textbook of the radiographic diagnosis of trauma claims that the diagnosis is best determined in the lateral projection.<sup>7</sup> This was at variance with our experience. Thus a study of methods to improve the roentgenographic diagnosis to augment previous reports in the literature is considered desirable.

## METHOD

Routine anteroposterior pelvic roentgenograms were reviewed in a series of 70 consecutive patients filmed for various reasons. A point of interest in this study was the specific evaluation of the continuity of the anterior superior sacral foraminal line (Fig. 1). Observations on the random anteroposterior roentgenograms are presented in Table 1.

A similar analysis of 16 cases of a fracture of the sacral ala is tabulated in Table

II. Lateral roentgenograms of the sacrum when available were reviewed.

The diagnosis of fracture was considered convincing if at least one of the following was evident: (1) repeated demonstration of healing in serial anteroposterior views; (2) demonstration on special views such as angle projections perpendicular to the concavity of the sacrum; (3) tomographic demonstration; (4) recognition by both the original reporter and, independently, by a reviewer on any single roentgenogram. Four of these cases are reported in greater detail.

## REPORT OF CASES

CASE I. D.H., a 35 year old female pedestrian, sustained left femur, left tibia and fibula frac-



Fig. 1. This random normal anteroposterior pelvic roentgenogram typifies the symmetric appearance of the frequently visualized first, second and third anterior superior sacral foraminal lines. White arrows outline the left third anterior superior sacral foraminal line. Black arrows outline the right first anterior superior sacral foraminal line.

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Table I

ANALYSIS OF ROUTINE PELVIC ROENTGENOGRAPHY

	Visualized Contour	Per Cent Visualized	Discontinuity	Per Cent Discontinuity	
Right				-	
ist ASSFL*	69	99	0	0	
2nd ASSFL	67	96	0	0	
3rd ASSFL	55	79	0	0	
4th ASSFL	16	23	0	0	
Left					
ist ASSFL	69	99	ĭ	I	
2nd ASSFL	67	96	I	ı	
3rd ASSFL	51	73	0	0	
4th ASSFL	15	21	0	0	

<sup>\*</sup> Anterior superior sacral foraminal line.

tures, and bilateral pelvic ramus fractures when struck by a car (Fig. 2). A vertical fracture of the left sacral ala including a discontinuity of the left second anterior superior sacral foraminal line was not identified initially. Supplementary projections of the sacrum with the x-ray beam angle perpendicular to the concavity of the sacrum as well as frontal tomography confirmed the presence of a fracture. Neurologic examination was compromised by the extensive left leg fractures, but no definite neurologic deficit was identified. Associated with the fracture of the sacral ala was an ipsilateral transverse process fracture of the fifth lumbar vertebra.

Case II. L.M., a 22 year old female driver with her lap seat belt fastened, sustained a mild cerebral contusion and facial injuries when her automobile was struck. Her main complaint was considerable pain in the region of the right sacroiliac joint posteriorly and this was associated with tenderness, but the neurologic examination was normal. Initial review of both pelvis and lumbosacral spine roentgenograms revealed no fracture (Fig. 3). In this setting of significant trauma with very specific focal symptoms and physical findings, additional roentgenographic evaluation was performed. Sacral views with various degrees of angulation were not helpful. Frontal pluridirectional to-

TABLE II

ANALYSIS OF SACRAL FRACTURE CASES

	Visualized Contour	Per Cent Visualized	Discontinuity	Per Cent Discontinuity
Right				
1st ASSFL*	15	94	2	12
2nd ASSFL	16	100	6	37
3rd ASSFL	12	75	4	25
4th ASSFL	3	19	0	0
Left	<del>, -</del>		<u></u>	
1st ASSFL	15	94	7	44
2nd ASSFL	16	100	9	56
3rd ASSFL	12	75	6	37
4th ASSFL	3	19	0	0

<sup>\*</sup> Anterior superior sacral foraminal line.



Fig. 2. Case I. A standard pelvic roentgenogram exemplifies a typical pelvic fracture involving the left sacral ala that can be accurately identified by noting the discontinuity of the left second anterior superior sacral foraminal line (black arrow). Also present are bilateral pubic ramus fractures and ipsilateral fifth lumbar transverse process fracture (white arrows).

mography confirmed the diagnosis (Fig. 4). Further evaluation was unnecessary and she was asymptomatic on follow-up at 6 weeks.

Case III. K.L., a 52 year old male, was assaulted and found unconscious with multiple rib and scapular fractures. Two days later on regaining consciousness he complained of left hip pain, and tenderness was noted over the left sacroiliac joint. Neurologic examination revealed decreased sensation on the lateral aspect of the left foot and an absence of the deep tendon reflex at the left ankle. No sacral fractures were initially identified on standard pelvic roentgenography or on angled projections of the sacrum (Fig. 5). The presence of a marked amount of bowel gas overlying the sacrum obscured the bone architecture. Frontal pluri-

directional tomography simply and unequivocally identified the fracture of the sacral ala involving the left first and second anterior superior sacral foraminal line (Fig. 6). No other fractures or dislocations were identified, even on follow-up filming that demonstrated healing of the fracture of the left sacral ala.

Three months later he developed new complaints of severe low back pain and on reexamination new findings suggested a left first sacral nerve root lesion. Lumbar myelography revealed an extradural compression of the left first sacral nerve root overlying the fifth lumbar disk space. At surgery fragments of the fifth lumbar disk were identified compressing the left first sacral nerve root.

Case IV. A.T., a 30 year old male, jumped 30 feet in a suicide attempt. His principal injuries were pelvic ring fractures involving the left acetabulum and left iliac wing, plus bilateral pelvic ramus fractures. A vertical fracture of the right sacral ala involving the first and third anterior superior sacral foraminal line was not initially identified, but was confirmed on follow-up films and on review of the original film. Initial neurologic examination was reported as normal, but on identifying the fracture, careful repeat neurologic examination revealed a decreased deep tendon reflex at the right ankle and decreased sensation in the area supplied by the right third sacral nerve. These abnormalities resolved over the next several weeks.

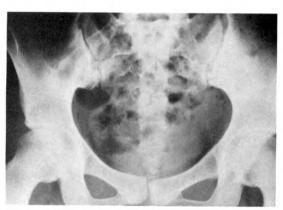


Fig. 3. Case II. A standard pelvic roentgenogram presents a more difficult diagnosis. A sacral fracture can be suspected from the altered contour of the right anterior superior sacral foraminal line but absence of other pelvic fractures as well as overlying bowel gas may prevent correct diagnosis.

#### RESULTS

The frequency of adequate bilateral visualization on routine pelvic roentgenograms of the anterior superior sacral foraminal line ranges from 75 per cent for the third sacral foramina to 99 per cent for the first sacral foramina. This frequency is sufficiently high to be useful. The anterior superior sacral foraminal lines are symmetric except for rare exceptions. In only I case, not related to fracture, was a discontinuity in this contour identified, which on subsequent films proved to be a superimposition of structures including the posterior aspect of the ipsilateral sacroiliac joint.

At least 1 anterior superior sacral foraminal line was disrupted in each of the 16 cases of vertical fractures of the sacral ala. In typical difficult cases, particularly with extensive overlying bowel gas, frontal tomography of the sacrum proved to be the most expeditious method to confirm a fracture. Certain pelvic ring fractures such as those in the ipsilateral pelvic rami (11/16) as well as fractures of the ipsilateral transverse process of the fifth lumbar vertebral body (7/16) are frequently associated with sacral fractures. Their presence should stimulate close investigation of the anterior superior sacral foraminal line.

Only 6 patients with sacral fractures had



Fig. 4. Case II. A frontal pluridirectional tomogram of the sacrum clearly demonstrates discontinuity of the right second arterior superior sacral foraminal line (white arrow).

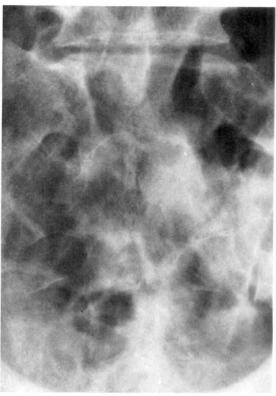


Fig. 5. Case III. An anteroposterior roentgenogram of the sacrum with central ray perpendicular to the concavity of the sacrum is difficult to evaluate because of overlying bowel gas.

roentgenography of the sacrum in the lateral projection, supplemented in 2 by lateral pluridirectional tomography. No fractures in this series were identified by evaluation of the lateral roentgenograms of the sacrum.

## DISCUSSION

The presence of multiple injuries in the traumatized patient often prevents optimal clinical evaluation for both sacral fracture and for associated sacral nerve injury. A discussion in detail of the neurologic evaluation is beyond the scope of this paper and the reader is referred to the excellent discussion by Bonnin.¹ Case IV clearly supports Bonnin's contention that the neurologic injury is not recognized because of inadequate examination. Once the sacral fracture is identified, attention should be directed towards a more thorough

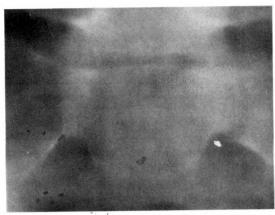


Fig. 6. Case III. On a frontal pluridirectional tomogram of the sacrum, a fracture of the left sacral ala is identified by the discontinuity of the left first anterior superior sacral foraminal line (white arrow). The confusing overlying bowel gas present on the plain roentgenogram (Fig. 5) has been eliminated by tomography.

neurologic examination.

Cases II and III are particularly noteworthy in that these were isolated fractures of the sacrum. In Case II the patient's major complaint was related to this lesion. The utilization of tomography permitted conclusive diagnosis and appropriate management. In Case III the utilization of tomography confirmed the sacral fracture which may have accounted for the patient's initial symptoms.

Meticulous attention to the continuity of the anterior superior sacral foraminal line will allow proper identification of most fractures of the sacral alae. In the setting of multiple trauma the roentgenologic diagnosis is compromised often by the presence of urgent clinical problems, difficulty in positioning the traumatized patient, and the frequent association of paralytic ileus. When the clinical suspicion is high and routine pelvic roentgenography of the sacrum is inconclusive, the addition of frontal tomography will improve the diagnostic accuracy. Contrary to reports in the literature, lateral filming with or without tomography is not as successful in identifying the vertical fracture of the sacral ala.

## SUMMARY

The importance of the evaluation of the continuity of the anterior superior sacral foraminal line was determined in a review of 16 vertical fractures of the sacral ala.

On initial evaluation 11 of the 16 fractures (70 per cent) had not been identified. The results of analysis of 70 consecutive routine pelvic roentgenograms is reported with emphasis on the anterior superior sacral foraminal line.

The value of tomography in the difficult case is emphasized.

Reported in greater detail are 2 cases of isolated sacral fracture, heretofore considered a rare lesion.

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## BONE CHANGES IN CONGENITAL BILIARY ATRESIA\*

## RADIOLOGIC OBSERVATION OF 8 CASES

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CONGENITAL biliary atresia is one of the tragic diseases of infancy. Many reports have been published on operative procedures and their results,<sup>2,6,9</sup> but reports on complications of this disease are quite limited. Recently, we have noted an extraordinarily high incidence of cervical herniation of the lung in congenital biliary atresia.

The following report concerns bone changes in 8 cases of biliary atresia encountered at Juntendo University Hospital.

## REPORT OF CASES

All the roentgenograms of 38 cases of biliary atresia were reviewed and 8 cases were detected to have certain types of osseous abnormalities. They are listed in Table 1. Generalized demineralization of bones was seen in 30 cases out of 38 cases, but this change was intentionally excluded from this report because of lack of objectivity. Laboratory data, dated close to development of radiologic abnormalities of the bones, are summarized in Table 11.

Case I. Y.K., I year old girl. She was a product of full term with birth weight of 3,250 gm. Neonatal period was unequivocal, but her stool had never been yellowish. Clinical examination at 2 months revealed jaundice and acholic stool. She was admitted to Juntendo University Hospital at 2.5 months and hepatoportojejunostomy with interposition of the jejunal loop was performed. She was re-admitted at 11 months with pneumonia.

Roentgenogram revealed marked generalized demineralization of bones with pencil line cortices and multiple minute fractures (Fig. 1).

Case II. T.M., I year, 2 month old boy. He was delivered at full term with birth weight

of 2,800 gm. Jaundice and acholic stool were present at 2 months and laparotomy was performed. This disclosed absence of extrahepatic biliary duct but no particular reconstruction could be performed. Massive hematemesis by rupture of esophageal varices was noted at 1 year and 2 months and he expired soon thereafter.

Roentgenogram showed irregularity in proximal metaphyses of both humeri, suggestive of disturbance of enchondral ossification (Fig. 2).

Case III. K.K., 5 month old girl. She was delivered at full term with birth weight of 2,720 gm. Jaundice had been noted since birth. Biliary atresia was diagnosed at 3 months. Uncontrollable pyothorax developed on the right before surgery could be performed and she expired at 5 months.

Roentgenogram showed square-shaped proximal metaphyses of both femurs, which might indicate a disturbance of funnelization of the metaphyses (Fig. 3).

Case IV. T.M., 5 month old girl. She was a product of full term with birth weight of 3,200 gm. She had been suffering from progressive jaundice, in association with acholic stool, since birth. Laparotomy was performed at 2 months and disclosed absence of extrahepatic biliary duct. Hepatoportojejunostomy with interposition of jejunal loop was performed at 5 months, because her jaundice had become progressively worse.

Roentgenogram at this stage showed irregularity in the proximal metaphyses of both humeri (Fig. 4).

Case v. M.S., I year old girl. She was delivered at full term with birth weight of 2,500 gm. Jaundice developed at I month, with alternation of stool color, blue to acholic. Hepatoportojejunostomy (Roux en Y) and Talma's procedure were performed at 2 months. She was

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Case	Sex	Age	Epi-metaphysis	Diaphysis	Fracture	Clinical Findings
1. Y.K.	F	ı yr.	ţ	+++	+++	Soft bones; hepatoportojejunos- tomy; expired at 1 yr. of age
2. T.M.	M	1 yr., 2 mo.	+			Laparotomy (2 mo.) expired at 1 yr., 2 mo. (rupture of esophageal varices)
3. K.K.	F	5 mo.	+			Expired at 5 mo. (rt. pyothorax), no surgery
4. T.M.	F	5 mo.		_	****	Interposition, enterostomy (5 mo.)
5. M.S.	F	ı yr.	+	+++	+++	Hepatoportojejunostomy plus Talma's procedure, expired at 1 yr.
6. N.U.	M	3 mo.			+	Rib fractures, enterostomy (Roux en Y, 3 mo.)
7. A.M.	F	1 yr., 7 mo.	+	+++	- ?	Soft bones, spiculation of femur, hepatoportojejunostomy (Roux en Y), enterostomy, expired at 1 yr., 7 mo.
8. M.S.	F	7 yr., 10 mo.	_	- ;	+	Fracture of rt. femur, hypoplasia of patella, cholecystojejunostomy (Roux en Y, 7 mo.), thoracic duct drainage (8 mo.)

re-admitted with severe pulmonary infection and expired soon after.

Roentgenogram showed pneumonic consolidation in both lungs, irregularity in proximal metaphyses of both humeri, multiple rib fractures and thin cortices of the bones (Fig. 5).

Case vi. N.U., 3 month old boy. He was a product of full term with birth weight of 2,660 gm. Brown colored urine, acholic stool and jaundice were noted by the mother 3 weeks after birth. Hepatoportojejunostomy (Roux en Y) was performed at 2.5 months.

TABLE II

LABORATORY DATA DATED CLOSE TO OSSEOUS ABNORMALITIES

Case*	TP	GOT	GPT	A-P	LDH	LAP	D-B	T-B	TTT	ZTT	P	Ca	Na	K	Cl
1. Y.K.		126	103	100	580	767	16.2	30.0	3.2	0.8	1.2	3.7			
2. T.M.	4.4	500	190	28	695	229	11.9	23.4	8.0	15.5					
3. K.K.	6.3	87	47	33.6	731	346	17.8	36.8	10.0	14.2					
4. T.M.	6.5	274	236	91.2	548	462	8.0	13.0	9.4	16.7			139	4.8	
5. M.S.	7.2	161	71	117.1	431	691							149	4.6	103
6. N.U.	6.0	147	66	90.6	860	1018	5.4	9.1							
7. A.M.	4.2	116	57	20.2	620	350	13.8	28.5	7.6	14.9					
8. M.S.	7.1	214	108	58.6	460	316	12.8	20.2	4.7	3.3	3.3	4.3	141	3.8	108

<sup>\*</sup> Cases are same as in Table 1.



Fig. 1. Case 1. Y.K., 1 year old girl.

Anteroposterior view of both femure shows marked decrease in bone density with pencil-line thin cortices and multiple minute fractures. Bone trabeculae show loss of definition.

Roentgenogram showed fractures of the right ribs with some callus formation. There was no particular history of trauma to the thoracic cage (Fig. 6).

Case VII. A.M., I year, 7 month old girl. She was a product of full term with birth weight of 3,550 gm. She had been suffering from jaundice since birth, with acholic stool. Hepatoportojejunostomy with enterostomy was performed at 4 months. She was re-admitted with deteriorated general condition and ileus at 9



Fig. 3. Case III. K.K., 5 month old girl.
Anteroposterior view of both hips shows square-shaped femoral necks (arrows).

months. Ileus was treated operatively. Final admission was at I year and 7 months with marked deterioration of general condition. She expired despite extensive supportive treatment.

Roentgenogram of autopsy specimen was available and it showed thin cortices of femur with periosteal elevation and spiculations (Fig. 7). Further details of this case will be reported elsewhere.

Case VIII. M.S., 7 year, 10 month old girl. She was a product of full term with birth weight of 2,460 gm. Jaundice and acholic stool were noted by her pediatrician at 2 months. Laparotomy was performed and extrahepatic biliary atresia was confirmed (type A Gray and Skandalakis<sup>1</sup>). Cholecystoduodenostomy and sublingual drainage of thoracic duct were performed at 7 and 8 months, respectively. Her postoperative course had been uneventful until

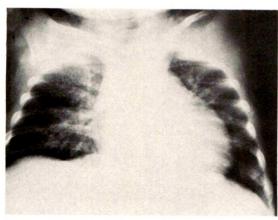


Fig. 2. Case II. T.M., I year, 2 month old boy.

Anteroposterior chest roentgenogram shows irregularity in proximal metaphyses of both humeri, better demonstrated on the right (arrows).

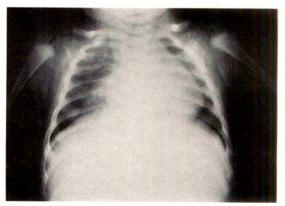


Fig. 4. Case IV. T.M., 5 month old girl.

Anteroposterior chest roentgenogram shows slight irregularity in proximal metaphyses of both humeri (arrows). There is loss of definition of zone of provisional calcification.

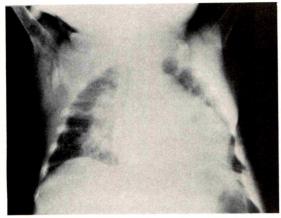


Fig. 5. Case v. M.S., I year old girl.

Anteroposterior chest roentgenogram shows pneumonic consolidation in both lungs, cardiomegaly, irregularity in proximal metaphyses of both humeri, multiple rib fractures and thin cortices of the bones.

March 16, 1971, when she was re-admitted with epi- and subdural hematoma. During her second hospitalization, a fracture of the right femur was found incidentally without any particular traumatic history.

Roentgenogram showed oblique fracture at distal shaft of the right femur with thin cortices and coarse bone trabeculae (Fig. 8).

## DISCUSSION

Although osteoporosis is not specific for liver diseases, it is a well known fact that osteoporosis may develop as a compensatory reaction to a systemic protein deficit

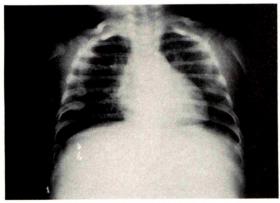


Fig. 6. Case vi. N.U., 3 month old boy.

Anteroposterior chest roentgenogram shows fractures of right 6th and 7th ribs with some callus formation.



Fig. 7. Case VII. A.M., I year, 7 month old girl.
Roentgenogram of autopsy specimen (left femur) shows thin cortices with periosteal spiculations. Bone trabeculae are coarse and thin. (With permission of Japanese Journal of Pediatric Surgery.)

as a result of hepatic dysfunction. Biliary liver fibrosis develops more or less in biliary atresia, with resultant growth retardation, muscle atrophy, anemia, hypoproteinemia and other deficiency symptoms.<sup>7,9,10</sup> There-



Fig. 8. Case VIII. M.S., 7 year, 10 month old girl.

Anteroposterior view of both femurs shows oblique fracture of distal shaft of right femur.

Cortices are thin and bone trabeculae are coarse.

(1) The Paris (1)

fore, it is easy to understand why osteoporosis occurs frequently in biliary atresia. In our series, we found 30 cases out of 38 cases with biliary atresia who showed roentgenographically visible osteoporosis.

On the other hand, ricketic changes may occur in liver diseases with or without roentgenologic manifestations of abnormal enchondral ossification at the metaphyses.

Lelong et al.<sup>3,4</sup> reported 17 observations in infants showing 4 significant anomalous manifestations: premature birth; prolonged jaundice; subacute pneumonitis; and rickets with prolonged osteomalacia. They also pointed out that bone changes could present 2 aspects: rickets, and total damage of skeleton characterized by decrease of the osseous denseness, irregular frame, broadening of the medullary cavity, and thinning of the cortices.

The occurrence of rickets is frequent in the course which lasts longer than 4 months (7 observations in 10); and the second type of bone damage occurs in all cases after 6 months.

In infantile hepatitis, occurrence of rickets is seen more frequently and earlier than in malformation of the biliary tract. Our cases show similar characteristics.

Levin<sup>5</sup> presented 2 cases of biliary atresia which caused 2 varieties of osseous dystrophies. He described 2 distinct types of osseous abnormalities: one type is rickets with roentgenographic manifestations of poorly mineralized bowed bones, coarse trabecular pattern, increased depth of the epiphyseal cartilage, frayed cupped widened ends of the diaphyses, coxa vara, genu valgum and triradiate pelvis; the second type is osseous dystrophy manifested by hypomineralized bone with ground glass appearance, pencil-line thin cortices, widened medullary cavity, undertubulation of the diaphyses with box-like rectangular conformation, normal or decreased depth of the epiphyseal cartilage and smooth thin zone of provisional calcification.

Similar to the classification of Levin and Lelong of the bone abnormalities in hepatic diseases, our series could be divided into 3 types of manifestations: ricketic change of the metaphyses; osseous dystrophy manifested by marked demineralization of bones; and fractures. As shown in Table 11, our 8 cases showed impaired liver function, but there was no close relationship between occurrence of osseous abnormalities and severity of the hepatic dysfunction. This must be further investigated.

Effective treatment of the osseous abnormalities is not available. Administration of large doses of vitamins A and D has been suggested by some, but consistent response has not been obtained. Actually, vitamin D must be activated in the liver and kidneys to regulate calcium metabolism. Thus, administration of vitamin D is probably not effective in biliary atresia, which demonstrates hepatic dysfunction of a certain degree.

#### SUMMARY

In reviewing 38 cases of biliary atresia, 8 cases were detected to have osseous abnormalities.

We found definite generalized demineralization of bones in 3 cases, metaphyseal abnormalities in 5 cases, and fractures in 4 cases. Marked demineralization of bones was seen in cases in which the clinical course was more than 1 year.

No good correlation was observed between osseous changes and severity of liver dysfunction.

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# PRIMARY TUMORS OF THE CLAVICLE AND SCAPULA\*

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PRIMARY tumors of the long-bones are well known and have been extensively described in the literature. Little, however, has been written about the clavicle and scapula and no individual series of any size has been reported in the radiologic literature.

Our purpose in reviewing these tumors was two-fold: (1) to try to establish the relative incidence of the various histologic types; (2) to attempt to differentiate them on roentgenologic grounds.

## MATERIAL AND METHOD

All primary tumors at these 2 sites seen at Memorial Sloan-Kettering Cancer Center between 1930 and 1974 were reviewed from both pathologic and roentgenologic viewpoints. All cases with inadequate data were discarded. Metastatic lesions were excluded. Solitary myeloma, however, was included. Eosinophilic granulomas and osteochondromas if multiple were also excluded. All soft tissue tumors with secondary involvement of bone were excluded. Two cases of synovial sarcoma were thus excluded.

Approximately 4,000 tumors are listed in the Bone Tumor Registry. In view of the paucity of reports of any sizeable series of tumors in these 2 bones, the listings of the various tumors at these sites in Dahlin's monograph and the Radiological Atlas of Bone Tumors by the Netherlands Committee on Bone Tumors were extracted. Dahlin's monograph is based on approximately 4,000 patients and the Atlas on 3,000 cases.

# FINDINGS BENIGN TUMORS (Tables 1 and 11)

True benign neoplasms of these 2 bones are much less common than malignant lesions. 1,6,11,14,16,20,28 Thus, of 17 true neoplasms of the clavicle only 3 were benign. In the scapula, in the series, only 15 of 80 lesions were benign. These figures are very

Tables I to IV show the distribution and numbers of the various types of tumors both benign and malignant in the clavicle and scapula. The individual figures are compared with those extracted from Dahlin's monograph<sup>8</sup> and from the Netherland's Committee on Bone Tumors.<sup>31</sup>

Table I BENIGN TUMORS OF THE CLAVICLE

	Smith et al. MSKCC	Dahlin <sup>8</sup> Mayo Clinic	Netherlands Committee on Bone Tumors <sup>31</sup>
Chondroma	0	0	2
Osteochondroma	2	1	0
Non-ossifying			
Fibroma	0	0	I
Chondroblastoma	0	0	0
Osteoblastoma	0	0	ı
Angioma	I	0	0
Tumor Like Aneurysmal Bone		The second secon	
Cyst	4	*	5 .
Eosinophilic	-T		,
Granuloma	3	*	I
Fibrous Dysplasia	ī	*	ı
Solitary Bone Cyst	I	*	I

<sup>\*</sup> Not Classified.

<sup>\*</sup> Presented at the Seventy-fifth Annual Meeting of the American Roentgen Ray Society, San Francisco, California, September 24-27, 1974.

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Fig. 1. Sessile osteochondroma of scapula.

similar to those of Dahlin, who reported 1 out of 24 clavicular lesions and 30 out of 56 scapular lesions.

OSTEOCHONDROMAS
(Fig. 1 and 2)

These were the commonest benign le-

TABLE II
BENIGN TUMORS OF THE SCAPULA

	Smith et al. MSKCC	Dahlin <sup>8</sup> Mayo Clinic	Netherlands Committee on Bone Tumors <sup>31</sup>
Osteochondroma	14	23	0
Chondroma	0	2	0
Chondroblastoma	I	3	0
Osteoid Osteoma	0	2	0
Osteoblastoma	0	0	I
Tumor Like Aneurysmal Bone			
Cyst	2	*	3
Fibrous Dysplasia Eosinophilic	I	*	*
Granuloma	6	*	I
Solitary Bone Cyst	I	*	I

<sup>\*</sup> Not Classified.

sions. They are relatively common in the scapula, which is one of the well-known sites for cartilage tumors. They varied in size, when seen here, but there was no benign tumor larger than 6 cm. The sites of involvement of the scapula with these tumors are characteristically at the superior inferior angles and at the base of the acromion. These are the sites of the secondary epiphyses and it is not surprising that this is where they should form. In this series there were only 2 osteochondromas of the clavicle and this bone represents a rare site for cartilage tumors. The ages of the patients with osteochondromas varied from 5 years to 61 years with an



Fig. 2. Tomogram of pedunculated osteo-chondroma of scapula.

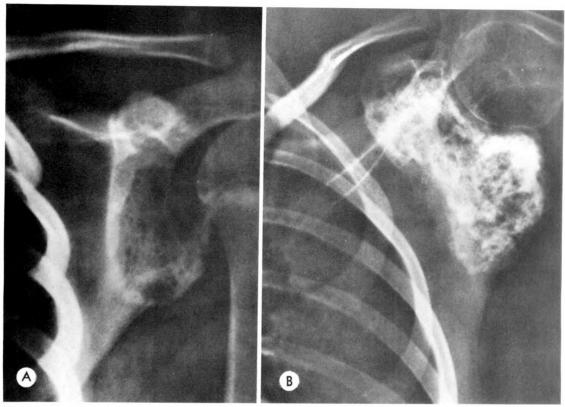


Fig. 3. (A) Chondroblastoma of glenoid. Note well defined area of destruction. (B) Chondroblastoma of glenoid 5 years later, following curettage of lesion. Lesion well ossified and remaining well healed.

average of 30 years. The average size of the tumors was 3 cm.

Apart from osteochondromas of the scapula, all other benign neoplasms in this region are rare.

CHONDROBLASTOMA (Fig. 3, A and B)

There was only I chondroblastoma seen in this series and despite scattered reports in the literature,<sup>29,33</sup> the scapula must be considered a rare site.

More common than the benign neoplasms, particularly in the clavicle, are the tumor-like processes, the aneurysmal bone cyst and eosinophilic granuloma.

ANEURYSMAL BONE CYST (Fig. 4, A and B)

There were 6 examples of aneurysmal bone cyst: 4 clavicular and 2 scapular. While these areas are not the most characteristic sites for these tumors, it is felt that the clavicle is not as rare a site as may appear. 16,20,24,28,31 A review of the literature reveals several patients with lesions at this site. True giant-cell tumors are extremely rare in this bone and one should be suspicious of the diagnosis of a true giant-cell tumor of the clavicle or scapula. It is far more likely to be, in fact, an aneurysmal bone cyst. All the aneurysmal bone cysts of the clavicle were found in the acromial end and showed very characteristic eccentric expansion with a thin cortical rim. A similar eccentric expansion was seen in the scapula. Of interest is the fact that 2 of the 6 patients with aneurysmal bone cysts were over 60 years old. This is a very unusual age for the demonstration of this tumor.

EOSINOPHILIC GRANULOMAS (Fig. 5, A and B)

These lesions, which are thought to be inflammatory in nature, are common in the

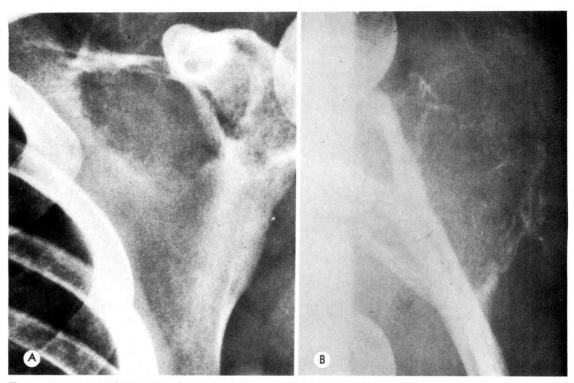


Fig. 4. Aneurysmal bone cyst of scapula. (A) Anteroposterior projection. (B) Lateral projection. Note the characteristic thin calcific shell overlying the area of destruction.

pediatric age group but they may occur in older individuals. 9,14,16-18 The oldest patient in this series was 39. The lesions usually have a benign appearance with well-defined margins and occasionally beveled edges. However, on occasion, the lesions may appear extremely destructive and there may be loss of cortical bone. In Figure 5 the original lesion of the clavicle was large and destructive, but the cortical rim was maintained. The other lesions in this series showed similarly a benign appearance. In 2 of the 6 patients with eosinophilic granulomas the lesions disseminated with multiple lesions being visualized within a few months of the original presentation.

## ANGIOMA

Angioma or hemangioma of the clavicle is a curiosity, but there are scattered reports in the literature. There was prominent periosteal spiculation but none of the classical honeycombing was seen

with this lesion. One of the unusual features in this patient was the associated soft tissue mass. This led to an original mistaken diagnosis of lymphoma at another institution, but review of all slides and a resected specimen showed a simple hemangioma.

# MALIGNANT LESIONS (Tables III and IV) CHONDROSARCOMA

This was the commonest malignant lesion. The shoulder is one of the classic sites for chondrosarcoma and it is not surprising that this headed the list of malignant tumors with a total of 24 cases. This is very similar to the findings in Dahlin's series (Tables III and IV). One of the most difficult diagnoses for the pathologist is the differentiation between a benign osteochondroma and a low grade chondrosarcoma. It is obviously impossible in the majority of these cases for the radiologist to

be of assistance. Very minor changes may be the only indication of malignancy. One of the helpful features in the differentiation from a roentgenologic point of view is the size of the lesion. By and large, chondrosarcomas are of a fair size when they initially present and most benign cartilage tumors are small. There were very few chondrosarcomas which were less than 6 cm. in size at the first examination. In a borderline case, obviously differentiation is very difficult. Roentgenographically these lesions may only show the characteristic speckled or stippled calcification of the cartilage cap (Fig. 6), but occasionally there may be very little in the way of calcification or ossification. They may simply be destructive lesions (Fig. 7) in which case roentgenographically they are very difficult to differentiate from other malignant tumors (Fig. 7). Periosteal reaction was not seen in any of the cases in this series. Twenty of the 24 cases had primary chondrosarcomas. Four were secondary to multiple osteochondromata.

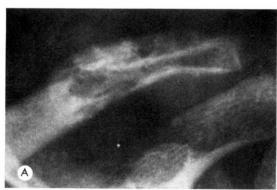




Fig. 5. Eosinophilic granuloma of clavicle. (A) Destructive lesion with expansion of its superior margin. Appearance rather simister. (B) Following curettage alone, the lesion healed completely and has remained healed.

TABLE III

MALIGNANT TUMORS OF THE CLAVICLE

	Smith et al. MSKCC	Dahlin <sup>8</sup> Mayo Clinic	Netherlands Committee on Bone Tumors <sup>31</sup>
Osteogenic			
Sarcoma	5†	3	0
Chondrosarcoma	2	5	0
R.C.S.	3	0	I
Ewing's Sarcoma	2	6	I
Myeloma	2	II	*
Fibrosarcoma	0	0	0

<sup>\*</sup> Not Classified.

### OSTEOGENIC SARCOMA

(Fig. 8 and 9)

There were 17 cases and this was the next most common of the malignant group. Of the 17 cases, 11 were primary and 6 were secondary. There were 4 postirradiation sarcomas and 2 Paget's sarcomas. There were 8 primary osteogenic sarcomas in the scapula compared with 20 primary chondrosarcomas at this site. The differentiation between these 2 types of tumors may be extremely difficult at times, especially since the age distribution is unusual for osteogenic sarcoma. The average age was 33, the youngest patient being 12 and the oldest 68.

	Smith et al. MSKCC	Dahlin <sup>8</sup> Mayo Clinic	Netherlands Committee on Bone Tumors <sup>31</sup>
Chondrosarcoma	24	20	II
Ewing's Sarcoma	14	12	5
Osteogenic			
Sarcoma	12†	II	3
R.C.S.	6	4	0
Hemangioendo-			
thelioma	5	0	0
Fibrosarcoma	3	5	3
Myeloma	I	4	*

<sup>\*</sup> Not Classified.

<sup>† 2</sup> Post Irradiation.

<sup>† 2</sup> Paget's Sarcoma. 2 Radiation Sarcoma.



Fig. 6. Chondrosarcoma of large size of scapula. Note typical calcifications of chondrosarcoma. There were 3 other osteochondromas visible in the ribs. The patient had multiple exostoses.

The mean age of patients with chondrosarcomas was 50, with the youngest being 16, and the oldest 69. The lesions in the clavicle were purely destructive. In the scapula there was usually a mixed pattern—lytic and blastic. In fact, the only bone lesion of the clavicle with new bone formation was a chondrosarcoma.

### RADIATION-INDUCED OSTEOGENIC SARCOMA

The development of osteogenic sarcoma following radiation therapy is now well documented.<sup>2,4,7,17,24</sup> The criteria described for inclusion of a case as described by Cahan *et al.*<sup>4</sup> were present in 4 patients.

Case I. (Fig. 10, A and B) A 15 year old girl presented with a large rock-hard mass in the lower neck. She had been born with a cystic hygroma and had received an unknown amount of roentgen radiation. The hygroma was later partially resected when she was 9 years of age. On admission here, she was found to have a malignant tumor which roentgenographically was very typical of an osteogenic sarcoma. She

died within a few months from widespread metastases.

EWING'S SARCOMA (Fig. 11 and 12)

The scapula was a relatively common site for Ewing's sarcoma. The picture roent-genologically resembles that of this sarcoma in other bones. Destruction, either permeative or geographic, and soft tissue mass predominated. Periosteal reaction was rare. Blastic changes were rare, but I dramatic case (Fig. 12) showed extensive blastic reaction. There were 14 cases in this series and this compares with 12 in Dahlin's series.

### RETICULUM CELL SARCOMA (Fig. 13)

A primary reticulum cell sarcoma of the bone is uncommon in this region. There was



Fig. 7. Chondrosarcoma of scapula. Large destructive lesion of coracoid process and soft tissue mass. No calcification within the lesion.



Fig. 8. Osteogenic sarcoma of scapula. Lesion predominantly blastic. There are also areas of destruction within it.

a total of 9 cases and the roentgenographic pattern was essentially nonspecific with geographic destruction and permeation.

### HEMANGIOENDOTHELIOMA

This extremely rare tumor was present in the scapula in 5 patients. The ages of the patients varied from 10 years to 78 years, but 3 were in their 30s. The total expe-

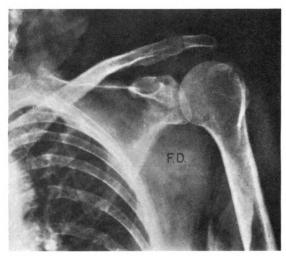


Fig. 9. Osteogenic sarcoma of scapula. Extensive destruction of the acromion process with associated soft tissue mass. No new bone formation is seen within the lesion.





Fig. 10. Radiation-induced osteogenic sarcoma of clavicle. (A) At the age of 9 years following an unknown amount of radiation to lower neck and shoulder for cystic hygroma. Note radiation changes in epiphysis and osteochondroma formation. Clavicle is normal. (B) Six years later, massive destruction of left clavicle with exuberant new bone formation.

rience at this hospital of this tumor extends to approximately 20 patients. Adequate data on prognosis are still inadequate. The lesion is fully malignant and capable of dissemination and 3 of the patients have died within 5 years. Of great interest is a physician of 32 who had presented with a lytic lesion in his humerus elsewhere 5



Fig. 11. Ewing's sarcoma of scapula. Note associated destruction and permeative involvement of the scapula.

years previously (Fig. 14A). This was diagnosed as an aneurysmal bone cyst. The lesion was curetted and packed with bone chips. A lytic lesion in the scapula was not treated. However, eventually the scapular lesion almost completely destroyed the scapula (Fig. 14, B and C) and a forequarter amputation was performed. The remainder of the skeleton at the time of amputation showed no abnormality. Within a year of the amputation a lytic lesion developed in one rib. Since then, he has been followed elsewhere. Apparently he has not developed any further metastasis.



Fig. 12. Ewing's sarcoma of scapula with bulky mass and dense new bone formation (arrow). Note deformity of upper chest wall by bulk of mass. Also note (arrow) large metastasis behind heart.

#### MYELOMA

The scapula and clavicle are not rare sites for involvement in myelomatosis; however, as a site for solitary myeloma it was relatively unusual in our series and only 3 patients are included.

#### DISCUSSION

The differential diagnosis between the various malignant lesions of the scapula is extremely difficult. Frequently one is able to indicate that it is a cartilage tumor and, because of destruction, that it is malignant. However, quite often the lesion might look benign on the roentgenograms and still represent an aggressive chondrosarcoma. Osteogenic sarcomas are much less common, but nevertheless they do occur in the scapula and may occur in older age groups than is usual with osteogenic sarcomas elsewhere. When there is prominent sclerosis, osteogenic sarcoma should be considered, but more patients in this series had destructive lesions than productive ones. Malignant lesions of the clavicle are rare and differentiation between osteogenic sarcoma, chondrosarcoma and the round-cell tumors is excessively difficult.



Fig. 13. Reticulum cell sarcoma of scapula. Large area of permeative destruction with loss of cortex.

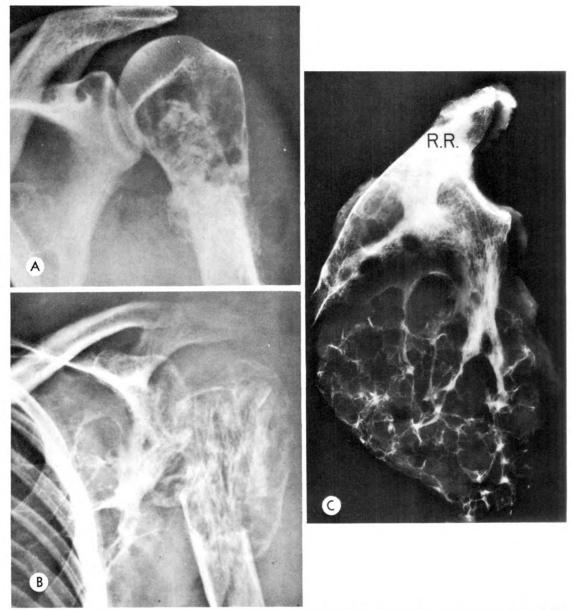


Fig. 14. Hemangioendothelioma of humerus and scapula. (A) Destruction of upper humerus packed with bone chips in 1964. Lytic lesion in scapula. (B) Five years later massive destruction of scapula. Further destruction of upper humerus with pathologic fracture. (C) Roentgenogram of resected scapula showing the very extensive honeycombed destruction by the tumor.

Age is, however, helpful in the differentiation of these tumors; thus, a destructive lesion in the clavicle in a young patient is more likely to be a round-cell tumor than an osteogenic sarcoma. In the scapula in a young patient the most likely diagnosis is an Ewing sarcoma, but reticulum cell sarcoma also has to be considered.

Of interest is the fact that despite the size of some of these tumors in the scapula and clavicle, they very rarely crossed to involve the other bone.

The only patients in this series who had both bones involved were those with radiation-induced sarcomas and hemangioendotheliomas. Both these lesions were essentially multifocal. The portal of radiation treatment in lesions of the shoulder girdle usually includes both bones, and thus it is not surprising that when radiation sarcoma occurs, both bones are involved.

Hemangioendotheliomas frequently may be localized to the bones of one extremity. There may even be skip areas. In the patient described, it was quite obvious that there was disease in the scapula at the outset. Another of the patients with hemangioendothelioma of the scapula also showed involvement of the clavicle. Prognosis is poor, but patients with multiple lesions have been reported to have a better prognosis than patients with single lesions.<sup>26</sup>

#### CONCLUSION

While the statistical analysis of the tumors at the various sites is useful, it must be concluded that as primary neoplasms of bone elsewhere, roentgenographic features are not specific and biopsy proof is necessary for most of these lesions.

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# VERTEBRAL AND COSTAL OSTEOCHONDROMAS CAUSING SPINAL CORD COMPRESSION\*

By JACK TWERSKY, M.D.,† E. GEORGE KASSNER, M.D.,† MICHAEL S. TENNER, M.D.,† and ANTHONY CAMERA, M.D.,† BROOKLYN, NEW YORK

OSTEOCHONDROMAS (exostoses) of the vertebrae or posterior ribs are a rare cause of spinal cord compression, usually in individuals with hereditary multiple exostoses (HME).<sup>4,5</sup>

We have observed 3 children with this complication, I of whom had HME.

#### REPORT OF CASES

CASE I. Solitary osteochondroma. C.F., a 12 year old boy, presented with a 3½ week history of difficulty in walking, loss of equilibrium in both lower extremities, and fecal and urinary incontinence. Physical examination revealed spastic paraplegia and a sensory level at T6. Roentgenograms of the spine showed a calcified mass to the right of T<sub>4</sub>-6 and erosion of the adjacent vertebral bodies (Fig. 1A). Myelography demonstrated a complete block at T<sub>4</sub> (Fig. 1, B and C). At operation a bony mass (covered with a cartilaginous cap) was seen arising from the posterior portion of the right fifth rib and invading the bodies of T4, T5, T6 and T7. A decompression laminectomy was performed and the intraspinal component of the tumor was excised. Pathologic diagnosis of the intraspinal and extraspinal tumor was osteochondroma. The patient has made a complete neurologic recovery.

Case II. Solitary osteochondroma. K.R., a 13

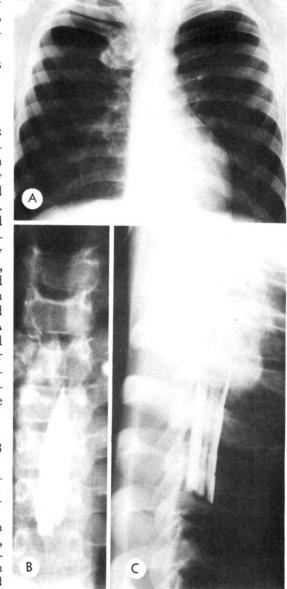


Fig. 1. Case 1. (A) An osteochondroma arises from the right fifth rib at the costovertebral junction, spreading the ribs and eroding the adjacent vertebral bodies. (B and C) Myelograms. There is an extradural block at T<sub>4</sub> displacing the spinal cord to the left and flattening it as seen in the lateral view.

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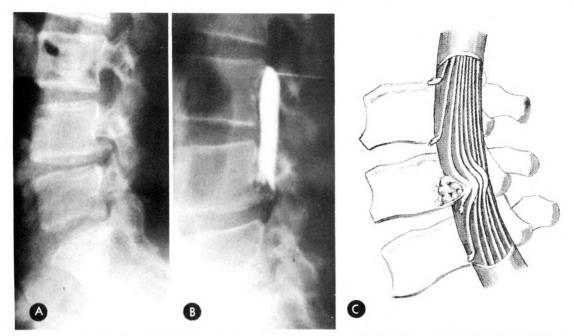


Fig. 2. Case II. (A) A small osteochondroma arises from the posterior inferior surface of L4. Frontal roent-genograms showed that the bony mass was in the midline. (B) Myelogram. There is an extradural block at the level of the osteochondroma. (C) Sketch of the operative findings. The osteochondroma has compressed the nerve roots and displaced them posteriorly.

year old boy, presented with a 9 month history of lumbar pain and bilateral sciatica. Physical examination revealed deep tenderness over the L4-5 region, limitation of straight leg raising and a positive jugular venous compression test. Roentgenograms of the spine showed a spurlike bony mass that projected into the spinal canal from the posterior inferior margin of L4 (Fig. 2A). Myelography revealed a virtually complete block at this level (Fig. 2, B and C). Laminectomy was performed and a bony mass capped with cartilage was excised. Pathologic diagnosis was osteochondroma.

Case III. Hereditary multiple exostoses. J.R., an II year old girl, presented with a  $2\frac{1}{2}$  month history of progressive numbness and weakness of both lower extremities and urinary and fecal incontinence. The patient, her sister and father were known to have HME. On physical examination bony masses were palpable about the knees and wrists; roentgenograms revealed typical features of HME (Fig. 3A). There was spastic paresis of both lower extremities and loss of pain and temperature sensation to the T2-3 level. Roentgenograms of the spine revealed an osteochondroma arising from the head of the left fourth rib which extended

into the vertebral canal (Fig. 3, B and C). Myelography revealed an extradural mass which produced a complete block at T<sub>4</sub> (Fig. 3D). At operation the bony mass was seen to be growing through the intervertebral foramen and compressing the spinal cord (Fig. 3E). Laminectomy was done at T<sub>3</sub>-5 and the tumor was resected. The pathologic diagnosis was



Fig. 3. Case III. (A) Typical features of hereditary multiple exostoses (HME) in both lower extremities.

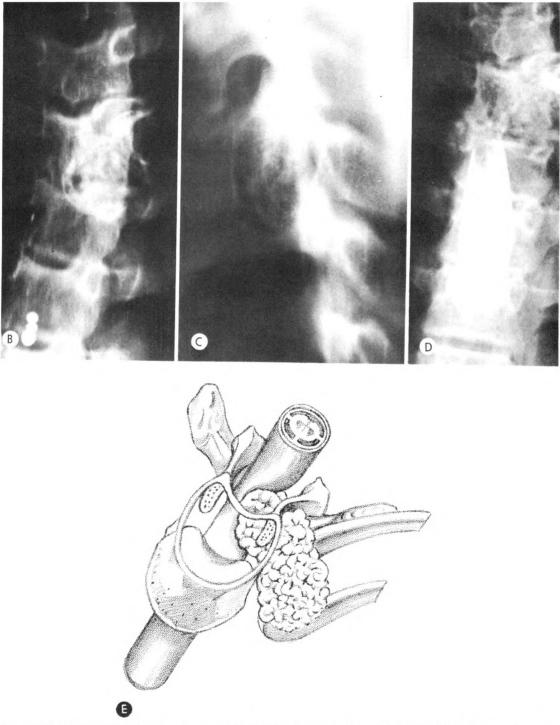


Fig. 3. (B) An osteochondroma arises from the left fourth rib at the costovertebral junction and extends cephalad and medially into the spinal canal. (C) Lateral tomogram. The osteochondroma elevates and erodes the left pedicle of T<sub>4</sub>. (D) Myelogram. Extradural block at T<sub>4</sub>. (E) Drawing of operative findings. The osteochondroma originates from the head of the lower rib and extends medially above the vertebral body through the intervertebral foramen which it has markedly enlarged to enter the spinal canal and compress the spinal cord.



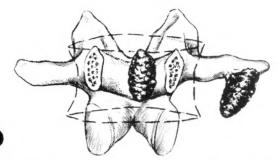


Fig. 4. Adult male with HME; no neurologic abnormalities. (A) Frontal projection of L4. (B) Drawing of posterior elements of L4 with vertebral body rendered transparent. Small osteochondromas arise from the left transverse process and posterior arch. The osteochondroma of the posterior arch, which extends into the spinal canal, was clearly seen only on tomograms.

osteochondroma. Six months after surgery the patient continues to have a spastic paraparesis; bowel and bladder function have returned to normal.

#### DISCUSSION

The precise incidence of vertebral and costovertebral osteochondromas is not known. About 3 per cent of solitary osteochondromas occur at these sites. Vertebral and costovertebral osteochondromas have been said to occur in 7 per cent of individuals with HME. The true incidence may be considerably higher, since close scrutiny of the roentgenograms may be needed to detect them (Fig. 4, A and B).

Osteochondromas can arise from any zone of endochondral bone formation.<sup>3</sup> Tumors that cause spinal cord compression generally arise from posterior vertebral elements or from the heads of the ribs.<sup>6</sup> Osteochondromas of costal origin may reach great size and cause marked vertebral erosion without producing signs of spinal cord compression (Fig. 5). Osteochondromas arising from the vertebral bodies are much less common. Intracranial exostoses arising on the clivus or in the spheno-occipital synchondrosis have been described.<sup>5</sup>

Spinal cord compression complicating osteochondromas has generally occurred in adolescents or young adults.<sup>4</sup> Including this report, only 1 of 16 patients was older than 33 years; 6 were 10–15 years old, sug-

gesting that signs of spinal cord compression are particularly likely to appear in youngsters with HME when the adolescent growth spurt causes enlargement of a critically positioned osteocartilaginous mass. Significant delay in diagnosis has been the rule; nevertheless, most patients have made adequate neurologic recoveries.

Patients with HME often have extensive roentgenographic examinations of the extremities but no roentgenographic examina-

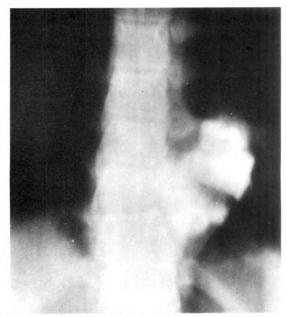


Fig. 5. Adult male; no neurologic abnormalities. A large solitary osteochondroma arises from the left 10th rib at the costovertebral junction and erodes the 9th, 10th and 11th vertebral bodies.

tion of the spine. We believe that it is important for individuals with HME to have baseline roentgenograms of the spine. Young patients should have rather frequent clinical evaluations and a careful neurologic examination at each visit. Because the onset of neurologic damage may be insidious, we believe that vertebral and costovertebral osteochondromas that encroach on the spinal canal should be excised.

#### SUMMARY

Three children, one with hereditary multiple exostoses (HME), had osteochondromas arising from vertebral body or posterior rib that caused spinal cord compression. This complication has generally occurred in adolescents and young adults with HME.

Baseline roentgenograms of the spine and repeated neurologic evaluations are indicated in young people with HME.

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### NORMAL VARIATIONS AND LESIONS OF THE SPHENOID SINUS\*

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A WIDE range of normal variation is recognized in the development of the sphenoid sinus. <sup>1-5</sup> On roentgenograms, some normal variations so closely simulate pathologic entities that without proper clinical correlation they may be a cause of misdiagnosis.

Various diseases are found in the sphenoid sinus which may involve the sinus either in primary or in secondary fashion. A wide spectrum of positive roentgenographic signs is associated with many of these conditions, some of which are fairly characteristic of the lesion.<sup>3</sup>

From a collection of material encountered during the past several years, a number of illustrative cases were selected to demonstrate the role which radiology plays in the diagnosis of disease of the sphenoid sinus.

This presentation is not meant to be a complete compendium of all conditions of the sphenoid sinus; rather, it is a concise demonstration of developmental variations of the sphenoid sinus, some of which are definite congenital anomalies, others are normal developmental variations, and a few are examples of pathologic entities which these variations simulate.

### CLASSIFICATION OF THE DEVELOPMENTAL VARIATIONS

For convenience, the developmental variation of the sphenoid sinus may be classified into 3 categories; (A) aplasia and hypoplasia; (B) variation in septation; and (C) variation in aeration.

### A. APLASIA AND HYPOPLASIA

Aplasia of the sphenoid bone is rare. The most frequently encountered aplasia is of the greater and the lesser wings, which is associated with pulsating exophthalmus on the side of the aplasia. Most of these are associated with neurofibromatosis. Aplasia of the sphenoid body is extremely rare, and this is usually associated with midline cleft of the face and the base of the skull. As a result, the meningeal structures herniate through such a cleft and present into the nasal or oral cavity (Case 1). Such a defect is clinically obvious soon after birth. but roentgenographic demonstration of the bony defect is much more definitive than the clinical estimation by observation and palpation. The presence or absence of brain substance within the herniated meningeal sac can be determined by the pneumoencephalogram or carotid angiogram.

CASE I. Nasopharyngeal meningoencephalocele associated with aplasia of the sphenoid body and extensive midfacial cleft (Fig. 1).

This is a newborn infant male who soon after birth was noted to have a large bulging cystic mass on the roof of the mouth associated with a widely cleft lip and palate. The mass filled the oral cavity. Transmitted pulse was felt on the surface of this mass.

Hypoplasia of the sphenoid sinus may be an isolated condition due to the lack of sufficient aeration in the sphenoid body (Case II), or a part of a complex midfacial and cranial base hypoplasia, such as Apert's syndrome (Case III). In isolated hypoplasia, it is quite frequently overdiagnosed as a diseased sinus and the patient is often subjected to multiple unnecessary diagnostic tests, even surgical exploration. This is because of a resemblance of a small sphenoid sinus to a clouded sinus. The key to the

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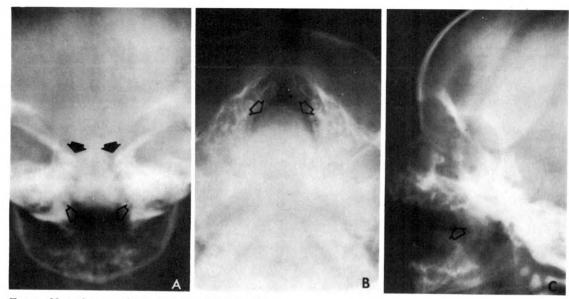


Fig. 1. Nasopharyngeal Meningoencephalocele. Case 1.

(A) Anteroposterior, (B) steep Waters', and (C) lateral roentgenograms of face and anterior skull show a large "soft tissue mass" in the oral cavity, growing downward from the roof of the mouth (open arrows). Extensive midline facial and basal cranial cleft is noted on anteroposterior view (solid arrows on A).

proper diagnosis is the roentgenographic demonstration of a very small but well-aerated sphenoid sinus. This is easily accomplished by the use of thin-section to-mography of the sphenoid body. In this situation, the ingrowing walls of the sphenoid sinus which have not expanded far enough to be in apposition with the bony cortex of the body of the sphenoid will be demonstrated. When the sphenoid hypoplasia is a part of a complex midfacial and cranial base anomaly, recognition of the condition is facilitated by the presence of multiple deformities in the adjacent structures.

## CASE II. Isolated hypoplasia of the sphenoid sinus (Fig. 2).

This is a 33 year old white male who was referred to us with a tentative diagnosis of either sinusitis, osteitis, or possible mass in the sphenoid sinus. One year history of intermittent occipital headache relieved by analgesics, and a  $1\frac{1}{2}$  month history of a mild throbbing right frontotemporal headache were given. One month prior to the examination given by the referring physician, the patient noted the onset of tinni-

tus. There was one episode of vertigo of an objective nature, lasting approximately 2 minutes. This vertigo was not associated with other sensory or motor dysfunction or disturbance in consciousness. The outside roentgenographic examination of the sinuses was interpreted as showing sclerotic disease of the sphenoid sinus that could be osteitis, osteoma, or osteochondroma. Subsequent complete diagnostic workup was essentially negative for organic disease.

### CASE III. Apert's syndrome (Fig. 3).

This is a 17 year old white female who was born with Apert's syndrome. Multiple congenital anomalies, including anomalies of the face with underdeveloped maxilla, zygoma and forehead were noted. As a result, hypertelorism, proptosis, and cleft palate were present. There were multiple syndactylies of the hands and feet. History of multiple surgical procedures was given; 1956, cranioplasty; 1958, repair of the syndactyly; 1961, palatoplasty. Severe hypoplasia of the maxilla has resulted in a moderate Class III dental occlusion.

The hypoplasia of the sphenoid body without an equally proportioned reduction in the size of the sella may give rise to a

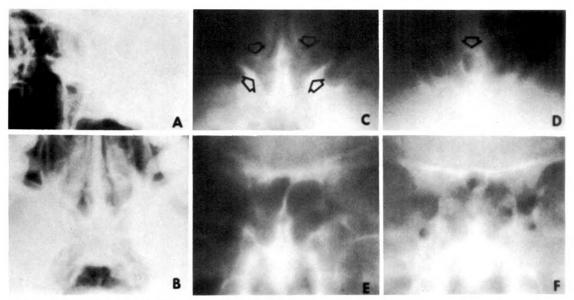


Fig. 2. Isolated Hypoplasia of the Sphenoid Sinus. Case II.

(A and B) Routine lateral and submentovertex views of the sphenoid sinus show either a lack of aeration or diffuse clouding of the sphenoid sinus. (C and D) Submentovertex tomograms, and (E and F) anteroposterior tomograms of the sphenoid sinus clearly demonstrate very small but well-aerated sphenoid sinuses (arrows). An isolated oval loculus is noted on the anterosuperior midline (arrow on D), outlined by its own cortical walls.

false impression that the sella turcica is enlarged due to an intrasellar mass lesion (Case IV).

Case IV. Pituitary eosinophilic adenoma (Fig. 4).

This is a 37 year old white female with acromegaly. Initial diagnosis of pituitary eosinophilic adenoma was made in 1969. Radiation therapy to the pituitary gland was administered in August, 1972. The chief complaint at that time was macroglossia, rhinorrhea, blurred vision, and occasional frontal midline headache. The patient noted continuous enlargement of her hands. The sella was noted to be enlarging continuously despite radiation therapy. Thyroid function determination, cortisol, and visual field tests were all normal. Growth hormone was elevated. In January, 1974, subfrontal hypophysectomy was performed with removal of a large quantity of semiliquid debris from the pituitary fossa. The histopathology was necrotic eosinophilic adenoma.

### B. VARIATION IN SEPTATION

Ordinarily, there is a bony septum which

divides the sphenoid sinus into the right and left sides. This septum is almost never on the midline. Occasionally, the septum may enclose a portion of the sphenoid sinus in such a manner that it may simulate an isolated sinus within the sinus (Case v).

Case v. Variation in septation—sinus in sinus (Fig. 5).

This is a 33 year old white female with chief complaint of nasal stuffiness associated with frontal headache. This was annually recurrent and worse in the late spring. The patient was clinically symptomatic at the time of this roent-genographic examination, but clinical examination disclosed no sinus disease.

An isolated loculus may be a small vesicle-like space within the septum or on the wall of the sphenoid sinus (see Case II). If the isolated spherical or disk-like loculus within the sinus becomes clouded, it may mimic a large polypoid mass, a cyst (Case VI), or an expanding floor of the sella (Cases VII and VIII).

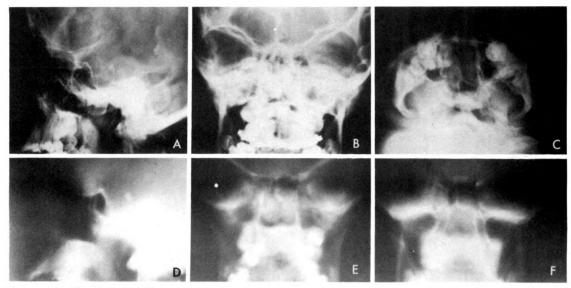


Fig. 3. Apert's Syndrome. Case III.

(A-C) Routine lateral, Caldwell's, and submentovertex views of the facial region; (D) tomographic lateral, and (E and F) anteroposterior views show flat, scaphoid face due to hypoplasia of multiple midfacial and basal cranial structures. Relatively small sphenoid body makes the sella appear abnormally

### CASE VI. Mucous retention cyst (Fig. 6).

This 28 year old woman presented with "intolerable" headache. Physical examination was not remarkable except for low grade fever. A brain scan was negative. Routine sinus roentgenograms revealed a density in the sphenoid sinus. This density was noted to have grown in size during the past 9 months. Tomography of the sphenoid sinus revealed a homogeneous well-marginated mass density within the sinus. The following day, the patient developed proptosis of the right eye. The patient subsequently had a transnasal sphenoid sinus drainage of a retention cyst.

## CASE VII. Variations in septation with sinusitis (Fig. 7).

This is a 69 year old critically ill white male. He was a tremendously obese, known alcoholic who was admitted with acute renal failure I week following left above-knee amputation. AK amputation was performed for a thrombosed popliteal aneurysm. Subsequently, multiple complications developed, such as aspiration pneumonia, acute and chronic pan-sinusitis, infarction of the right colon, septicemia, and metabolic encephalopathy. The patient was

also noted to have generalized severe arteriosclerosis and an abdominal aortic aneurysm. He was confused, with a flaccid left upper extremity and had xanthochromic spinal fluid.

## Case VIII. Pituitary eosinophilic adenoma (Fig. 8).

This is a 46 year old white male who developed gradual acromegalic changes of his face and body during the past 15 to 20 years. Confirmation of acromegaly was made by a fasting growth hormone value of 18 ng./ml., and a postglucose stimulation value of 13 ng./ml. at 1 hour, and 15 ng./ml. at 2 hours. Roentgenographic examination revealed an enlarged sella with mass extending into the sphenoid sinus. He denied any complaint of headache. The patient underwent transsphenoidal hypophysectomy which demonstrated extension of the pituitary mass into the sphenoid sinus, which was greater on the left. Histopathology was eosinophilic adenoma.

Infrequently, the persistence of craniopharyngeal canal may be seen, which will mimic an isolated loculus within the sphenoid sinus on submentovertex view (Case IX).

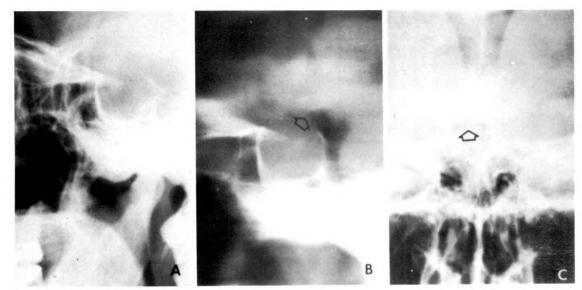


Fig. 4. Pituitary Eosinophilic Adenoma. Case IV.

(A) Plain lateral view of the sella-sphenoid sinus, (B) lateral midline tomogram, and (C) anteroposterior brow-up view during pneumoencephalography demonstrate marked expansion of the sella turcica encroaching upon the sphenoid sinus, which is due to an intrasellar soft tissue mass causing pressure erosion on the tuberculum and dorsum sellae. Suprasellar extension of the pituitary mass is well seen on pneumoencephalographic examination (arrow on B and C).

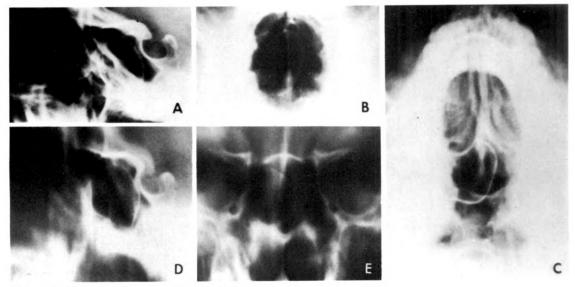


Fig. 5. Variation in Septation—I. Case v.

(A) Routine lateral, (B) modified Waters' (transoral), (C) submentovertex views, and (D) tomographic lateral and (E) anteroposterior views of the sphenoid sinus demonstrate an oval loculus surrounded by its cortical walls in the right sphenoid sinus. It has the appearance of the shell of a bird's egg attached to the right lateral wall of the sphenoid sinus. (Courtesy: John H. Beveridge, M.D., Nashville, Tenn.)

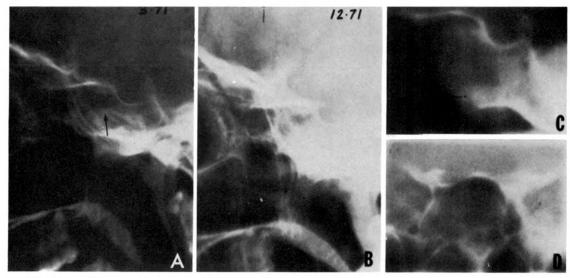


Fig. 6. Mucous Retention Cyst. Case vi.

(A) Lateral view of the sphenoid sinus in March, 1971, demonstrates sharply demarcated "water density" filling the entire floor of the sphenoid sinus. The surface of this demarcation is slightly undulating, but can be easily mistaken as air-fluid level (arrow). (B) Lateral roentgenogram of sphenoid sinus in December, 1971. The homogeneous soft tissue density has now a smooth convex surface encroaching more into the sphenoid sinus space. (C and D) The lateral and anteroposterior tomograms of the sphenoid sinus demonstrate oval, well-demarcated water density occupying most of the sphenoid sinus space. Note that there is no destruction of the sinus walls or expansion. (Courtesy of George B. Pratt, M.D., Indianapolis, Ind.)

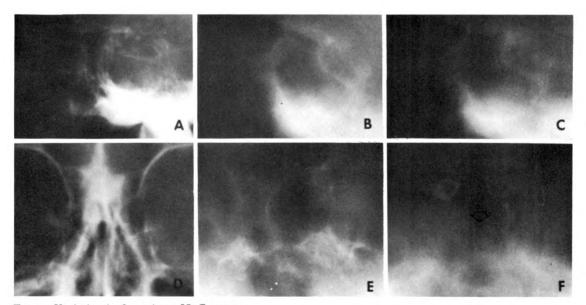


Fig. 7. Variation in Septation—II. Case VII.

(A) Plain film lateral, (B) lateral tomogram on the right, and (C) left side of mid-sagittal plane, (D) anteroposterior plain roentgenogram, and (E and F) anteroposterior tomograms of the sphenoid sinus demonstrate what appears to be a large unilateral expansion of the floor of the sella due to partial loculus of the right sphenoid sinus into a biconcave disk-like space, and the clouding of this loculated space by irregular mucoperiosteal thickening of chronic sinusitis (compare with Figure 8). Note intact floor of sella on F (arrow).

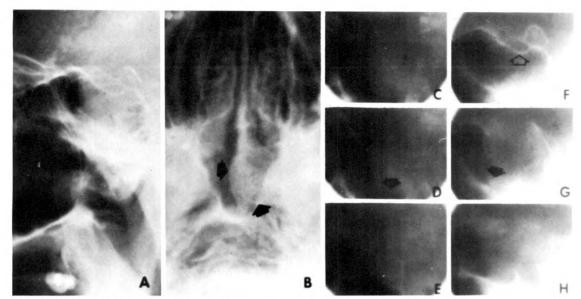


Fig. 8. Pituitary Eosinophilic Adenoma. Case viii.

(A and B) Routine lateral and submentovertex views demonstrate a well-marginated soft tissue mass within the sphenoid sinus (arrows on B), with seemingly intact sella. (C-E) Anteroposterior tomograms, and (F-H) lateral tomograms of the sella show this mass to be due to the unilateral expansion of the sella depressing and eroding the left floor down into the sphenoid sinus (solid arrows on D and G). Note still intact right margin of the floor of the sella (open arrows on D and F) and that the mass is not covered by cortical bone.

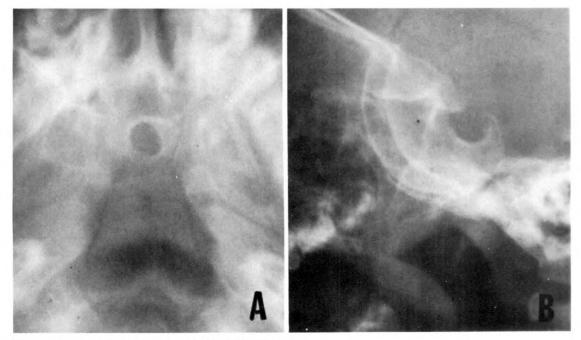
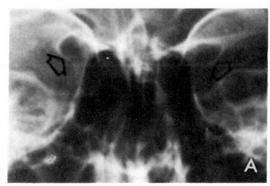


Fig. 9. Persistent Craniopharyngeal Canal. Case IX.

(A) Submentovertex and (B) lateral views of the sphenoid sinus demonstate cylindrical bony canal between the anterior floor of the sella turcica and the bony roof of the nasopharynx. Note that there is no recognizable pneumatization of the sphenoid body. On submentovertex view alone, one might mistake this centrally located radiolucency for an isolated, hypoplastic midline sinus (see Figure 2D).



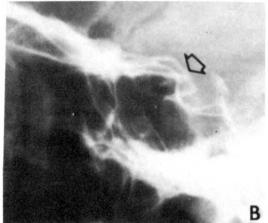


Fig. 10. Variation in Aeration. Case x.

Aeration of the sphenoid sinus may extend into its appendages.

(A and B) Aeration of the anterior clinoid processes.

### Case IX. Persistent craniopharyngeal canal (Fig. 9).

This child was noted shortly after birth to have difficulty feeding and mild respiratory distress. Examination of the oropharynx revealed a cystic mass depressing the soft palate. This mass was partially resected at 2 weeks of age and the pathologic diagnosis of fibroid epithelial cyst was made. Leaking of clear fluid, presumably cerebrospinal fluid, was noted for a few days after the operation. This ceased spontaneously. One year later the patient was readmitted. A tubular bony canal connecting the anterior portion of the sella turcica to the nasopharynx was noted on roentgenograms. On physical examination, the mass was again apparent on the soft palate. A second resection of the lesion was then performed with the same pathologic diagnosis. Clinical diagnosis of nasopharyngeal meningocele was not substantiated.

### C. VARIATION IN AERATION

Variation in aeration ranges from minimal, and consequently a hypoplastic sinus (see Case II), to extensive, with extension into the appendages of the sphenoid body, such as the anterior clinoid processes, the lesser wings, the greater wings, the pterygoid plates, and the posterior clinoid processes (Cases x, xI, and xII).

Cases x, xI, and xII. Variations in aeration (Fig. 10; 11; and 12).

These are cases with complaints unrelated to the paranasal sinuses. Variations in aeration demonstrated here are purely incidental observations.

Recognition of extensive aeration is clinically important with the involvement of the sinus by a disease, as aeration of these appendages increases the chance of exten-





Fig. 11. Variation in Aeration. Case XI.

(A and B) Aeration extension into the base of the left pterygoid process.

sion of the sinus disease to adjacent structures. Asymmetric expansion of the sinus space may yield a false impression that the smaller side is diseased because of the relative increase in density due to a smaller volume of air.

#### DISCUSSION

Because of its deep location and anatomic relationship with many important deep facial and intracranial structures, the sphenoid sinus presents a unique problem in clinical diagnosis.<sup>1–5</sup> Roentgenologic examination is probably the most effective and definitive method in solving many of the diagnostic problems arising from diseases of the sphenoid sinus.

In the roentgenologic evaluation of the sphenoid sinus it is essential to analyze the following points: (1) the location and integrity of the walls of the sinus; (2) the location, shape, and integrity of the septum; (3) the size of the sphenoid sinus and the presence of any space encroachment; and (4) the condition of the adjacent and contiguous structures.

Advantages and limitations of the conventional roentgenographic views of the sphenoid sinus are well known. Among these, modified Waters' view (transoral view) and submentovertex view, together with the lateral view will provide the essential preliminary information, but these will not be sufficient for critical evaluation of the sphenoid sinus itself because of the superimposition of surrounding structures on the roentgenogram.1,2 For this reason, modern thin-section tomography plays an indispensable role by enabling an examiner to observe every small part of the sinus without superimposition of the surrounding structures. There are instances in which a disease has extended beyond the sphenoid sinus without roentgenographically demonstrable destruction of its walls. In such a case, especially when it has extended into the cranial cavity, angiography and pneumoencephalography are very helpful.

Above all, the most important first step in the roentgenologic examination of the



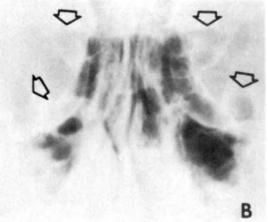


Fig. 12. Variation in Aeration. Case XII.

(A and B) Aeration extension into

(A and B) Aeration extension into the lesser wings (upper arrows) and greater wings (lower arrows on B). Generous aeration of the base of the pterygoid processes is also seen.

sphenoid sinus is the knowledge of developmental variation which will enable the observer to recognize those normal variations which closely mimic pathologic entities roentgenographically, and separate them from a real disease.<sup>3,5</sup>

### SUMMARY

- 1. A considerable amount of variation exists in the development of the sphenoid sinus. Classification of these variations for convenience in roentgenographic analysis is given.
- 2. For a complete evaluation of the sphenoid sinus, the routine sinus roentgenographic series is not sufficient. If a lesion in the sphenoid sinus is suspected, unless the lesion is quite obvious on routine roentgenograms, thin-section tomography should always be obtained.

3. Some abnormal and normal developmental variations of the sphenoid sinus are presented to emphasize the importance of recognition of normal variations which mimic disease.

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Photog., 1965, 41, 38-60.
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# JOINT CHANGES IN IDIOPATHIC HEMOCHROMATOSIS\*

By JACK TWERSKY, M.D. BROOKLYN, NEW YORK

A SPECIFIC arthropathy associated with idiopathic hemochromatosis has been well established.<sup>3,10,13</sup> Furthermore, the joint symptoms and roentgen findings can precede the major signs of cirrhosis, diabetes, and brown skin pigmentation.<sup>3</sup>

The radiologist can be the first to suggest the correct diagnosis on the basis of roentgenographic changes in the hands and large joints.

REPORT OF CASES

CASE I. V.B. is a 60 year old female with

biopsy proven hemochromatosis since 1953. For the past 10 years she has had pain and stiffness of both hands. For the past 5 years she has had pain in both knees and shoulders.

Roentgenographic examination of the hands revealed abnormalities of all of the metacarpophalangeal (M-P) joints (Fig. I, A and B). This was characterized by asymmetric joint space narrowing, eburnation of the subchondral bone (most prominent in the 2nd and 3rd M-P joints), and prominent osteophytes. Similar and less prominent findings were present in the (R) hand at the 1st interphalangeal (I-P), 2nd distal I-P and 3rd proximal I-P joints, and in the





Fig. 1. Case I. (A and B) Degenerative changes are present at all of the metacarpo-phalangeal joints. This is characterized by asymmetric joint space narrowing and prominent osteophytes.

<sup>\*</sup> From the Department of Radiology, State University of New York, Downstate Medical Center, Brooklyn, New York.



Fig. 2. Case I. Left shoulder. There is flattening of the head of the humerus, with subchondral sclerosis and an irregular surface of the subchondral bone, similar to an aseptic necrosis.

(L) hand at the 1st carpo-metacarpal joint. The (R) shoulder was unremarkable. The (L) shoulder had decreased joint space, irregularity of cortical border of humeral head with sclerosis and cystic change of the subchondral bone (Fig. 2). Both knees revealed chondrocalcinosis involving primarily the menisci, although the

articular cartilage of the (L) knee was also calcified (Fig. 3, A and B).

CASE II. F.B. is a 64 year old male, who presented with a 10 year history of arthritis of both hands and shoulders. For the past year there has been an increase in pain in both hands.

Roentgenographic examination of both hands revealed abnormalities of all the M-P joints characterized by asymmetric narrowing of the joint spaces, and prominent osteophytes (predominantly 2nd and 3rd M-P joints) (Fig. 4, A and B). Both shoulder joints had prominent osteophytes along the inferior margins of the humeral head and glenoid with sclerosis and cystic changes in the subchondral bone of the humeral head and glenoid (Fig. 5, A and B). Osteoarthritic changes were present in both knees. The (L) knee showed chondrocalcinosis of the menisci and articular cartilage (Fig. 6, A and B).

On the basis of the roentgenograms, an unusual form of osteoarthritis, possibly idiopathic hemochromatosis, was suggested. The patient was then admitted for further work-up. A liver biopsy revealed: "I. cirrhosis with mild fatty metamorphosis; 2. abundant hemosiderin pigment present in hepatic cells and in fibrous tissue;—Hemochromatosis."



Fig. 3. Case i. (A and B) Chondrocalcinosis is present bilaterally. This involves both the articular cartilage and the menisci, best seen in the (L) knee.



Fig. 4. Case II. (A and B) Degenerative changes are noted in the 2nd and 3rd metacarpo-phalangeal joints bilaterally. This is characterized by asymmetric joint space narrowing, irregularity of the subchondral cortex and unusually prominent osteophytes of the metacarpal heads.

### DISCUSSION

Schumacher,<sup>11</sup> in 1964, originally described a distinctive arthropathy associated with hemochromatosis. The 2 cases he described had prominent involvement of both hands, predominantly the M-P joints, with minimal clinical and biopsy evidence of inflammation. Kra et al.,<sup>5</sup> in 1965, reported in detail a similar case with joint changes in the shoulders and elbows. They stated that osteoarthritis best fit the clinical picture, although generalized joint involvement of the large joints was unusual. Hamilton et al.<sup>3</sup> evaluated 32 patients with hemochromatosis. They found clinical evidence of arthritis in 16. In 3 of

these patients, joint symptoms preceded the clinical diagnosis, although one of the major signs of hemochromatosis was present. In 2 others, the joint symptoms preceded all of the major signs of the disease. Hamilton et al.3 accurately described the roentgenographic findings in the hands as narrowing of the M-P (primarily 2nd and 3rd) joints, with erosion and segmentation of the underlying bone, and sclerosis and cyst formation. Of the 16 patients 10 had chondrocalcinosis, usually involving the menisci, although the triangular ligament of the wrist, symphysis pubis, hip joints, and ankle joints were occasionally involved. In I patient from this group histologic

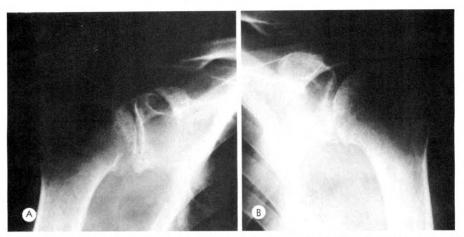


Fig. 5. Case II. (A and B) Both shoulders reveal identical abnormalities. There are narrowing of the joint space and subchondral sclerosis and cyst formation; osteophytes are seen at the inferior margin of both joints.

examination revealed crystals in rounded clumps in the synovial superficial layers. These had the characteristics of calcium pyrophosphate on polarized light microscopy. The study of Hamilton *et al.*<sup>3</sup> was extended by Dymock *et al.*<sup>2</sup> to include a total of 63 patients. The incidence of arthritis (50 per cent) and the clinical and roentgenographic findings were again confirmed.

The high incidence of chondrocalcinosis has caused speculation concerning the relationship between iron and calcium deposition. Atkins *et al.*<sup>1</sup> compared the previously reported group by Hamilton *et al.*<sup>3</sup> of patients with hemochromatosis arthropathy and chondrocalcinosis (I.H.) to a group of patients with idiopathic chondrocalcinosis (I.C.). Both groups had calcification of fibrocartilage, but the I.H.



Fig. 6. Case II. (A and B) Flattening of the medial tibial plateau and subchondral sclerosis are present bilaterally. Chondrocalcinosis of both articular cartilage and menisci in seen in the (L) knee.

group had a much higher incidence of calcification of hyaline cartilage. The distribution of joint involvement was also different, the I.H. group involving primarily the M-P joints and wrists, but also numerous large joints, while the I.C. group had primarily hip, knee and lumbar spine involvement. However, Martel and coworkers' analysis of 19 patients with pseudogout revealed both hyaline and fibrocartilage involvement, and severe osteoarthritic changes in multiple joints, including the M-P joints. These were indistinguishable from the changes seen in idiopathic hemochromatosis.

The exact role of iron in producing this arthritis has not been established. The incorporation of iron into bone and joint structures has been well studied. Past<sup>9</sup> injected rats with an iron-dextran complex. One hour after intravenous injection, iron was noted in the hypertrophic cartilage cells of the epiphyseal plates and small amounts of iron were present in newly formed trabeculae of the adjacent metaphysis.

That high blood levels of iron can result in an arthropathy is corroborated by:

- (1) the high incidence of arthritis in patients with idiopathic hemochromatosis;
- (2) reports of clinical arthritis associated with transfusion hemochromatosis;<sup>2,12</sup>
- (3) a degenerative arthropathy occurring in Asiatic Russia (Kashin-Beck's disease), related to chronic ingestion of iron in drinking water.<sup>4</sup>

In idiopathic hemochromatosis iron is present in the synovial fluid in the phagocytic synovial lining cells, and in the articular cartilage. However, no synovial inflammation is present. These findings suggest that iron has a direct deleterious effect on the articular cartilage, causing irreversible damage with resultant osteoarthritis. Furthermore, iron may inhibit pyrophosphatase enzyme activity in cartilage. Pyrophosphatase hydrolizes pyrophosphate to soluble orthophosphate. A

decrease in enzyme activity may permit precipitation of insoluble pyrophosphate crystals. This is compatible with Martel's<sup>6</sup> suggestion that patients with pseudogout probably have a primary cartilage degeneration with secondary chondrocalcinosis, rather than a primary disorder of calcium pyrophosphate precipitation. Iron can presumably cause the same pattern of cartilage degeneration. The pattern of distribution of joint involvement remains unexplained.

#### SUMMARY

Two patients with idiopathic hemochromatosis and a distinctive arthropathy are presented.

The joint findings are characterized by joint narrowing, prominent osteophytes, subchondral sclerosis and multiple lucent subchondral cysts, and chondrocalcinosis.

The etiology of this arthropathy and its relationship to chondrocalcinosis are discussed.

Occasionally, patients may present with this arthropathy before the onset of the classical signs of idiopathic hemochromatosis.

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# ADVERSE REACTIONS TO INTRAVASCULARLY ADMINISTERED CONTRAST MEDIA\*

### A COMPREHENSIVE STUDY BASED ON A PROSPECTIVE SURVEY

By WILLIAM H. SHEHADI, M.D.†

THE Committee on Contrast Media of The International Society of Radiology was established in 1969 during the XII International Congress of Radiology in Tokyo.

The Committee has the following objectives:

- Conduct a survey to determine the incidence of adverse reactions to contrast media used in diagnostic radiology.
- 2. Establish and maintain the organization for collecting, tabulating, and analyzing the data so obtained
- 3. Stress the necessity of reporting the adverse reactions as they occur
- 4. Isolate and evaluate predisposing causes leading to adverse reactions
- 5. Stress the importance of the problems and complications arising as a result of, or inherent in the various radiologic procedures utilizing contrast media
- 6. Develop measures that will prevent and/or effectively treat these reactions.

Radiologists in 30 teaching hospitals in the United States, Canada, Europe, and Australia are presently collaborating in a prospective survey on adverse reactions to intravascularly administered contrast media used in diagnostic radiology. A prospective study eliminates the flaws and shortcomings of a retrospective survey and should give much more complete data than a retrospective study. This is further en-

hanced by the confidential manner in which the reports are treated, eliminating the possibility of useful information being withheld for medico-legal or other reasons.

A report form (Fig. I) designed for computer processing is completed on each patient examined, whether or not an adverse reaction occurs. The form is simple and easy to complete, recording considerable and varied information; each report is individually checked and verified for computer purposes.

Items 1-3 are for identification

4-9 are for history of possible predisposing causes of a reaction—allergy, previous reactions, patients condition

10-11 method of examination, dose, and type of contrast media used

12-16 are filled only when a reaction oc-

Reactions are graded as:

- (1) Mild-no Rx needed
- (2) Moderate—Rx needed
- (3) Severe—hospitalization needed
- (4) Fatal.

### DATA COLLECTED AND RESULTS

The data collected to date, from a total of 112,003 cases, have been studied in detail and the basic information obtained is presented:

### 1. Nonfatal reactions

The incidence of nonfatal reactions is lower than is generally recognized (Table 1). For intravenous urography, the over-all incidence is 5.65 per cent, for intra-arterial studies the over-all incidence is 2.3 per

<sup>\*</sup> Presented at the Seventy-fifth Annual Meeting of the American Roentgen Ray Society, San Francisco, California, September 24-

<sup>27, 1974.
†</sup> Chairman, Committee on Contrast Media of the International Society of Radiology. Professor of Radiology, New York Medical College; Director of Radiology, Westchester County Medical Center.

At the national and international level, partial support has been received from the Food and Drug Administration (Contract 73-56 and 223-74-3085), E. R. Squibb & Son, Canadian Association of Radiologists, Mallinckrodt Pharmaceuticals, Nyegaard & Co., Schering A.G.

CONFIDENTIAL REPORT

### INTERNATIONAL SOCIETY OF RADIOLOGY COMMITTEE ON SAFETY OF CONTRAST MEDIA

### Pilot Study-ADVERSE REACTIONS FROM INTRAVASCULAR CONTRAST MEDIA

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### RETURN THIS COPY.

Fig. 1. Report form used in the survey.

This is provided in triplicate and is completed on every patient having an intravascular administration of a contrast medium, whether or not a reaction occurs. The first copy goes to computer processing, the second copy is retained in our files, and the third (bottom) copy remains in the files of the radiologist.

Table I
Incidence of reaction to various intravascular examinations

Type of Examination Performed	Total Number of Patients Examined	Total Number of Patients with Reactions	Total Number of Reactions	Incidence of Reactions
Peripheral arteriography	2,187	54	96	2.47
Cerebral angiography	7,354	162	270	2.20
Angiocardiography	3,310	47	67	1.42
Aortography	11,399	285	475	2.50
Venography	3,074	88	146	2.86
Other (splenoportography,	- 1		·	
hepatography, etc.)	304	8	12	2.63
Total vascular studies	27,628	644	1,066	2.33
Total intravenous urography	81,278	4,589	7,518	5.65
Total intravenous cholangiography	3,097	313	541	10.11
Total intravenous and intra-				
arterial examinations	112,003	. 5,546	9,125	4.95

cent. However, for intravenous cholangiography, the incidence remains high: 12.6 per cent single dose; and 8.16 per cent drip infusion, with an over-all incidence of 10.11 per cent.

A total of 5,546 patients (Table II) had a reaction, two-thirds (3,640) of these patients had a minor reaction which required no treatment. Approximately one-third (1,769) of the patients had reactions which required treatment in the radiology department. Thirty-eight patients had reactions which were sufficiently severe as to require hospital inpatient treatment and care. The distribution and intensity of the most com-

monly experienced reactions are shown in Table III.

### 2. Fatal reactions

There were II deaths recorded in our series: intravenous urography 6; intravenous cholangiography I; venography I; angiocardiography 2; cerebral angiography I.

The first 8 are contrast medium deaths. The last 3 deaths may be related to the procedures in patients with severe underlying disease, in whom death may have been precipitated by the contrast medium studies.

No pretesting was done in 7, pretesting

Table II
SEVERITY OF REACTION TO INTRAVASCULAR CONTRAST EXAMINATIONS

Type of Examination	Total Number of Patients	No RX		RX		RX Hospital		Fatal		Missing
Performed	with Reactions	Patients	Reactions	Patients	Reactions	Patients	Reactions	Patients	Reactions	Data
Peripheral arteriography	54	32	53	21	41	0	0	0	0	2
Cerebral angiography	162	117	199	32	50	3	5	I	1	15
Angiocardiography	47	14	20	29	41	3	3	2	3	0
Aortography	285	157	244	117	207	5	15	0	0	9
Venography Other (splenoportography,	88	56	85	28	51	2	3	1	5	2
hepatography, etc.)	8	4	7	2	3	0	۰	٥	0	2
Total vascular studies	644	376	608	227	393	13	26	4	9	2
Total intravenous urography Total intravenous chol-	4,589	3,067	4,882	1,439	2,437	18	64	6	16	30
angiography Total intravenous and intra-	313	197	312	103	197	7	23	1	2	119
arterial examinations	5,546	3,640	5,802	1,769	3,027	38	113	11	27	156

Table III

DISTRIBUTION AND INTENSITY OF THE MOST COMMONLY EXPERIENCED REACTIONS

Reaction	No RX	RX Necessary	Hospital Necessary	Total	As a Per Cent of Total Reactions
Vascular pain at site of injection	157	44	0	201	2.30
Flushing	695	395	0 '	1,090	12.47
Urticaria	333	1,283	8 .	1,624	15.58
Facial edema	31	187	10	228	2.61
Nausea	2,553	387	0	2,940	33.66
Vomiting	1,578	216	0	1,794	20.53
Drop in blood pressure	30	64	15	109	1.28
Ventricular fibrillation	0	8	3	11	.16
Cardiac arrest	0	0	9	9	.18
Circulatory collapse	0	0	23	23	.29
Difficulty in breathing	66	196	13	. 275	3.19
Laryngeal edema	0	31	5 6	36	.41
Pulmonary edema	.0	0	6 .	6	.08
Pulmonary infarction	. 0	0	0	0	00
Neurologic findings					
convulsions	I	6	6	13	.15
paralysis	0	2	6	8	.09
coma	0	I	r	2	.03
Other	222	116	8	346	3.97

was negative in 2, and positive in 2 (venography and intravenous urography).

## AGE DISTRIBUTION OF ADVERSE REACTIONS (Table 1v)

The incidence of reactions is highest in the third and fourth decades (20–40 years) and lowest at either end of the age spectrum. This is quite meaningful considering the clinical problems usually associated with the old and the very young.

Table IV

AGE DISTRIBUTION OF THE INCIDENCE OF REACTIONS

Age (yr.)	Total Number of Patients Examined	Total Number of Patients with Reactions	of
0 20	14,123	571	4.04
21–35	19,024	1,259	6.62
36–50	26,940	1,373	5.10
51–65	30,557	1,452	4.75
66–100	21,359	891	4.17
Total	112,003	5,546	4.95

# sex distribution (Table v)

The number of examinations in our series of 112,003 is practically equally divided between the 2 sexes. The incidence of adverse reactions is similarly divided (contrast media exhibit no sex discrimination).

# ALLERGY AND THE INCIDENCE OF REACTIONS (Table vi)

The over-all incidence of adverse reactions in patients with a history of allergy is

TABLE V
SEX DISTRIBUTION

Sex	Total Number of Patients Examined	Total Number of Patients with Reactions	of
Male	55,320	2,710	4.90
Female	56,683	2,836	5.00
Total	112,003	5,546	4.95

Table VI

INCIDENCE OF REACTIONS IN PATIENTS WITH KNOWN HISTORY OF ALLERGY

(AND RELATION TO SPECIFIC ALLERGENS)

Total number of patients with allergy 6851 Total number of patients with no reactions 6152 Total number of patients with reactions 699				Incidence of Reactions: 10.2 per cent				
Type of Allergy	(1) Total Number of Patients Examined	(2) Total Number of Patients with Reactions	(3) Incidence of Reactions	(4) Missing Data	(5) No RX	(6) RX	(7) RX in Hospital	(8) Fatal
Asthma	340	38	11.18	2	16	19	1	0
Hay fever, grass-ragweed	552	57	10.33	2	37	18	0	0
Allergy, general (not specified)	2,063	270	13.09	2	152	109	6	٥
Penicillin	2,286	171	7.48	- 4	99	63	2	I
Sulfa drug	449	35	7.88	2	18	15	0	0
Seafood, shell fish	207	31	14.98	0	13	16	ı	0
Fruit, strawberry plant	225	29	12.89	2	16	11	0	0
Eggs, milk, chocolate	82	12	14.63	I	4	7	0	0
Morphine, codeine Barbiturates, sodium pentothal,	294	26	8.84	0	17	9	٥	0
phenobarbital, aminophyllin	95	9	9.47	1	5	3	0	0
Aspirin, salicylates	258	21	8.14	1	10	10	0	٥

practically twice that of the general population. There were 6,851 patients with a history of allergy. Of these, 6,152 patients experienced no adverse reaction, while 699 patients or 10.2 per cent had reactions of varying intensity (Column 5, 6, 7; Table vI).

The risks in decreasing order are: (1) sea food and shell fish, 14.98 per cent; (2) eggs, milk, and chocolate, 14.63 per cent; (3) asthma, 11.18 per cent; (4) hayfever, 10.33 per cent; (5) penicillin, 7.48 per cent.

### PRETESTING

The incidence of reactions in patients who were not pretested and in patients with negative results to pretesting was the same as that of the general population.

Positive result to pretesting is a rare occurrence. The majority of reactions which occur after the full dose of contrast material has been injected are minor and require no treatment.

A total of 375 patients gave a positive response to the pretest. Upon completion of the injection of the full dose, 76 patients experienced no reaction whatever, 209 patients had minor reactions which required no treatment, and 87 patients had moder-

ate reactions which were treated while the patient was on the radiographic table. One patient needed hospital treatment. There were 2 deaths: I following intravenous urography; and I following venography. In addition, there were 5 other patients on whom the reaction to the pretest dose was sufficiently severe that the scheduled examination was canceled.

The practice of routine pretesting is rapidly vanishing. It is considered to be of no significant value.

The only pretests performed in our series were by the intravenous or intra-arterial injection of a small amount (0.5-1.0 ml.) of the contrast medium at the time of the examination.

The intradermal and subcutaneous pretests have completely vanished and not one such test was recorded in our series.

# INCIDENCE OF REACTIONS WITH HISTORY OF PREVIOUS REACTIONS (Table VII)

A history of reaction to previous examinations is not a contraindication to reexamination. Only 16.16 per cent of patients with a history of a reaction to the same previously performed examination

Table VII
INCIDENCE OF REACTIONS TO PRESENT AND PREVIOUS EXAMINATIONS

Number of patients with previous		
reaction to same examination Number of patients with reaction	1,714	
to present examination	277	16.16%
Number of patients with no reac-		
tion to present examination	1,437	83.84%
Number of patients with previous		-
reaction to other examination	204	
Number of patients with reaction		
to present examination	44	21.57%
Number of patients with no reac-		
tion to present examination	160	78.43%

are likely to react upon repetition of the examination. This is only 3 times that of the general population. With a history of reaction to a previous different examination, the reaction incidence is approximately 4 times that of the general population. However, the number of cases in this group remains too small to be statistically significant.

# INCIDENCE OF REACTIONS TO BOLUS INJECTION (SINGLE AND DOUBLE DOSE) COMPARED WITH A DRIP INFUSION

### (Table VIII)

The single bolus injection in intravenous urography is accompanied by a lower incidence of reactions (5.38 per cent) than the urographic drip infusion (7.06 per cent), which actually has a higher dose of contrast medium. There is, however, no significant difference between a single and a double dose.

On the other hand, the single bolus dose in intravenous cholangiography has a higher incidence of reactions (12.67 per cent) than the more slowly administered drip infusion (8.16 per cent) which actually contains the same dose of contrast medium. This is diluted to a relatively smaller total fluid volume (usually 100 ml.) than the urographic drip infusion (usually 300 ml.) which contains a larger dose of contrast material.

The larger urographic fluid volume, among other factors not yet determined, may contribute to the higher incidence of reactions in drip infusion urography.

### RELATION OF INJECTION TIME TO INCIDENCE OF REACTIONS

### (Table 1x)

In intravenous urography and vascular studies, rapid injection performed in less than 2 minutes, usually a few seconds to a minute, is accompanied by a lower incidence of reactions than when the injection is slow, 3 to 10 minutes. This is a reversal of the hitherto widespread practice of contrast media administration. The trend in the direction of rapid injection is evidenced by the fact that the vast majority of the radiologists participating in our program are partial to the speedy injection of the contrast medium.

However, the facts are reversed for intravenous cholangiography. The rapid injection of cholografin (iodipamide group) is accompanied by a high reaction incidence and considerable resultant toxicity. The slower injection results in a lower incidence of reactions and a greater safety margin. The optimal injection time is 10 minutes—whether by single dose or drip infusion.

### PREMEDICATION

Premedication had no significant effect in decreasing the over-all incidence of adverse reactions. In selected cases, considered to be high risk cases, it is quite likely that premedication is of help.

Judging from the reports accumulated in our survey, premedication is not a routine or common practice.

Prior to intra-arterial studies, sedation in some form is used on some of the patients.

Antihistamines and steroids are perhaps the most commonly used drugs for premedication. The incidence of reaction is at the 5 per cent and 4 per cent level, respectively.

Premedication and the interaction of drugs, and their relation to adverse reac-

Table VIII

COMPARISON OF INCIDENCE OF REACTIONS TO CONTRAST MEDIA-ROUTINE INJECTIONS AND DRIP INFUSION

	Total Number of Patients Examined	Total Number of Patients with Reactions	Incidence of Reactions
Intravenous Urography single dose double dose	57,347 11,622	3,022 690	5·27 5·94
Total Routine Dose	68,969	3,712	5.38
drip infusion	12,275	867	7.06
Grand Total	81,244	4,579	5.64

	Total Number of Patients Examined	Total Number of Patients with Reactions	Incidence of Reactions
Intravenous Cholangiography single dose drip infusion	1,318 1,779	167 146	12.67 8.16
Grand Total	3,079	313	10.11

tion call for a greater in-depth study than has so far been possible in this program.

### CONTRAST MEDIA UTILIZATION

In our series of 112,003 examinations, 72,923 were performed with contrast media

of the renografin series, 17,033 examinations with the conray series, 12,746 with the hypaque series, and 4,667 with the isopaque series.

The remaining examinations were performed with "other" contrast media.

Table IX
RELATION OF INJECTION TIME TO INCIDENCE OF REACTIONS

	Total Number of Patients Examined	Total Number of Patients with Reactions	Incidence of Reactions
Intravenous Urography			
0–2 min.	60,654	3,094	5.10
3–10 min.	18,603	1,385	7.45
II and over	2,021	110	5.56
Total	81,278	4,589	5.65
Intravenous Cholangiography			
0–2 min.	521	69	13.24
3–10 min.	1,718	189	11.00
II and over	858	55	6.70
Total	3,097	313	10.15
Vascular Studies (Intra-arterial)			
0–2 min.	26,924	626	2.33
3–10 min.	660	18	2.73
II and over	44	0	ō
Total	27,628	644	2.33

From the data so far obtained, it is obvious that the administration of the methylglucamine group is accompanied by a smaller incidence of reactions than those with the higher sodium content. The iothalamate group compares favorably with the methylglucamine group. The number of examinations with isopaque series remains statistically relatively small.

#### SUMMARY AND CONCLUSION

Case reports on 112,003 patients obtained through a prospective survey have been studied and submitted to computer processing. The significant findings have been reviewed and their importance discussed.

The following points are noteworthy: the value of pretesting is doubtful; and routine pretesting is not a recommended procedure.

The constant readiness of a fully equipped emergency tray offers far greater security and assurance of patient safety than the unpredictable and unreliable results of pretesting.

The over-all incidence of nonfatal reactions is lower than has been previously indicated: 5.65 per cent for intravenous urography; and 2.33 per cent for intravascular studies. The incidence of fatal reaction (1 in 10,000) is higher than that reported on the basis of retrospective studies. This figure may or may not be duplicated in the next 100,000 examinations. The cause of death in some patients may be related to a combination of factors—primary disease, diagnostic procedure, and contrast medium.

The over-all incidence of adverse reactions in patients with allergy is about twice that in the general population. The incidence of adverse reactions is highest in the third and fourth decades, and lowest at either end of the age spectrum. Incidence of reactions is equal in both sexes. History of reaction to previous examinations is not a contraindication to re-examination. The incidence is approximately 3 times that of the general population.

Rapid injection rate, in intravenous

urography, is accompanied by fewer reactions than a slow injection rate. A slow injection rate in intravenous cholangiography is accompanied by fewer reactions than a rapid injection rate.

It is anticipated that this program will continue, so that additional meaningful data and significant information will be accumulated.

The members of our Committee are of the firm belief that this program will become the foundation of a permanent national and international adverse reaction reporting system, thus meeting a great need.

We invite the collaboration and support of all those interested and involved in the many phases of contrast medium work.

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Data presented in this report were submitted, in part, by the following radiologists who are participating in this survey. We gratefully acknowledge their assistance and invaluable contributions.

Australia: Dr. Benness and colleagues; Belgium: Drs. DeBacker, Lemahieu, Leroux, Van De Velde, Verstraeten; Canada: Dr. MacEwan; Norway: Drs. Amumdsen, Aksnes, Larsen, Skalpe; United States of America: Drs. Alfidi, Brinker, Broghammer, Chan, Diner, Dodd, Donner, Dyke, Finby, Friedenberg, Girolamo, Heitzman, Kupic, Lapayowker, Miskhin, Pfister, Purnell, Ruzicka, Sanders, Shehadi, Stanley, Tampas, Taveras, Twigg, Thornbury, White, and Viamonte.

Additional data to be contributed by other participants in this survey will be included in future reports of this Committee.

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# m EDITORIAL m

### BONES AND BEYOND

DETECTION of disease in bones is a daily or hourly occurrence for the radiologist. It is part of what radiology is all about. The clinical value of the roentgen study is firmly established because bones lend themselves particularly well to roentgenologic examination, and, conversely, because some bone diseases present equivocal or late characteristic clinical manifestations.

The thoughtful, or observant, or inquisitive radiologist does not stop with the classification of disease: there is much more that roentgenograms can tell him. For example, after seeing a large number of patients together with their roentgenograms, the radiologist comes to realize that certain injuries produce certain fractures, that the type of deformity tells more than merely the fact of injury. It frequently tells also what happened to produce that injury. When the roentgenogram of the hand of a 15 year old shows a flake of bone separated from the anterior border of the articular surface of the proximal end of a middle phalanx, the experienced radiologist can confidently predict, before questioning the patient, that the injury was the result of an axial blow on the distal phalanx—almost always due to "catching" a ball on the tip of the finger.

Information such as this has been available for years. In a different age group, in a different age, the chauffeur's fracture of the radial styloid told the radiologist of an attempt to start a balky automobile with a crank. The careless driver grasped the crank handle with the thumb opposing the fingers around the handle. When the cylinder fired late, the crank handle snapped forcefully forward, fracturing the radius. Early radiologists recognized this common

fracture and its mechanism.¹ On the other hand the well indoctrinated driver grasped the crank handle with the thumb on the same side of the handle as the fingers, and substituted a mild bruise for the fracture. Technological advance (the self-starter) has eliminated this fracture mechanism.

Another way in which technological advance has altered the information behind the disease process is shown in consideration of certain rib fractures. In the past, in my practice in a wealthy suburb and in a central city hospital with an active emergency service, multiple rib fractures, particularly those of different ages, meant "falling down disease" in an alcoholic. More recently, encountered in a large teaching hospital, these rib fractures mean something entirely different. They are being seen more frequently in the resuscitated patient as a result of vigorous treatment of cardiac arrest. With the advent of this new technology one must be careful not to impugn incorrectly the habits of the patient.

Such examples of information, beyond the immediate problem, which is available in examination of the skeleton, can be multiplied many times. The ages at which a young patient experienced the more severe acute exanthemata can be guessed at by the distance of Park's postarrest lines² from the epiphyses of the long bones. A widened symphysis pubis usually means previous pregnancy. Fractures of both bones of both legs near the knees can be incurred in few ways other than being crushed between an automobile bumper and a wall

growing bone. Pediatrics, 1964, 33, 815-862.

<sup>&</sup>lt;sup>1</sup> Bertwistle, A. P. A Descriptive Atlas of Radiographs of the Bones and Joints: for Students and Practitioners. William Wood and Co., New York, 1924, pages 66, 67; and Fig. 9.

<sup>2</sup> Park, E. A. The imprinting of nutritional disturbances on

or another bumper.3 Hangman's fracture and clay shoveler's fracture are self-explanatory. Weaver's bottom, or ischial bursitis, likewise tells its own story, although the problem was current before the development of "Eine neue Art von Strahlen."4

In this deductive approach to skeletal radiology, we have much to learn from archaeologists. This type of thinking has been their stock in trade, a sine qua non of successful, or imaginative, archaeology, and in many instances a substantial edifice has been built on what appear to be only few facts. Although many of the abnormalities apparent in ancient bones are equivocal, distorted, obliterated, or even simulated by the conditions of preservation,5 the discovery of only I case of undisputed leprosy, for example, will establish that the disease occurred at that time and in that place. The archaeologist's picture of the past has been painted by innumerable, minute brush strokes made by innumerable workers, but a reasonable picture emerges. The multitudes of facts which have become available are interpreted, rearranged, and fitted into a coherent description of the way of life of people of that time. Careful analysis of this sort can bring forth surprising statements based on apparently limited data.

An example of this type of reasoning appears on consideration of forearm and ankle fractures. Among the remains of ancient peoples in England and western and northern Europe, fractures are common. In particular, forearm fractures are seen in many specimens, and they are usually of the Colles' type, the result of falling on the outstretched forearm and wrist. They occasionally occur in association with Pott's fractures of the ankle, and the fractures usually have healed with more or less deformity. Presumably the fractures result from active life, such as hunting, or agriculture carried out on rocky or at least uneven ground. Bulky footwear, necessitated by the climate, may have contributed to an individual's instability. Practically all of the Colles' fractures are found in men, indicating that they were the active sex at that time and in that region.

In contrast, among the Egyptians, as shown by some 10,000 skeletons available from ancient times, there were few ankle fractures. The reasons which are suggested to explain this disparity include: walking barefooted, as they did, they had a much more sensitive awareness of the ground on which they walked; the fields which they tilled were washed smooth by the annual inundation of the Nile; and they did much less hunting. Of equal interest, however, is the great difference in forearm fractures. Among ancient Egyptians these fractures were almost all seen in women, and were in the ulna—the parry fracture—sustained in warding off a blow, and practically none was encountered in the radius. The conclusions are obvious to an archaeologist, and with these data he can elucidate some of the characteristics of personal and family life. Among the Angles, Saxons, and Celts, life was hard, men spent their time hunting, or tilling unfriendly ground. Among the Egyptians (of that long-past time), life was easier, fields were smooth and fertile, and men spent at least part of their time beating their wives. One unfortunate teen-age Egyptian girl is represented by a skeleton which shows unhealed parrying fractures of both ulnae, and her efforts were apparently vain, as she sustained a skull fracture severe enough to be fatal. She was 4 or 5 months pregnant at the time of her death, and speculation as to the relationship between this fact and her death strains even the archaeologist, interesting though it is.

Similar analyses are possible to the interested or imaginative radiologist today. Degenerative joint disease frequently develops more rapidly in those joints which are subjected to the greatest use. Flexion and extension of the head on the thorax in

<sup>3</sup> STERN, W. G., and PAPURT, L. E. Healing of the newer bumper fractures of the tibia. J.A.M.A., 1935, 105, 2147-2150.

No reference is necessary for readers of this Journal. <sup>5</sup> DECKER, F. H., and BOHROD, M. G. Medullary artefacts in

prehistoric bones. Am. J. ROENTGENOL., 1939, 42, 274-5.

<sup>6</sup> Wells, C. Bones, Bodies and Disease. Vol. 37 of Ancient Peoples and Places. General Editor, Dr. Glyn Daniel. Thomas and Hudson, London, England, 1964.

most people occur principally in the lower cervical spine, while rotation occurs almost entirely in the upper cervical segments. Might it not be possible to speculate on a woman's personality, or past, by noting whether there is more degenerative disease in the upper or lower cervical spine? Whether there had been more nodding or more rotation of the head? Might not the multipara have more degenerative disease in the lower cervical region, and the happily unmarried or childless, more degenerative change in the upper cervical spine?

Radiology advances in many ways. Technological advances permit more exact diagnosis, classification of a disease which might not have been accessible before, decrease in patient irradiation, or elimination of more time-consuming procedures. But advances which are more satisfying to

a certain type of radiologist occur not by the use of new methods, but by new ways of looking at what we have been looking at for years. Examples of this type of advance are numerous: noting the position of the fat stripes at the wrists; recognizing pericardial effusion in the conventional lateral view of the chest; understanding the rearrangement of pulmonary blood flow in incipient left ventricular failure; evaluation of the lymph flow at the periphery of the lung base. Thus, advances occur both by reasoning about the material at hand, much in the manner of the archaeologist, as well as by the development of new techniques. With such thoughtful analysis added to new techniques, the vistas of radiology remain limitless.

E. Frederick Lang, M.D.



### **NEWS ITEMS**

### ISRAEL RADIOLOGICAL SOCIETY

The annual meeting of the Israel Radiological Society will be held in association with the Israel Medical Association at the Ichilov Hospital, Tel Aviv, Israel, Wednesday, May 17, 1975.

It will be devoted to the subject of the development and abnormalities of the skull and spine.

The opening address will be the annual Rigler Lecture by Dr. Robert Shapiro, New Haven, Connecticut: "The Development of the Human Skull,"

### AMERICAN CANCER SOCIETY

Eleanor Roosevelt International Cancer Fellowships

The International Union Against Cancer, with the funds provided by the American Cancer Society, will award fellowships for research on cancer.

The awards will be granted to experienced investigators who have demonstrated their ability for independent research and who wish to broaden their experience by a period of study at a single institution in another country.

Fellowships will be granted only to persons on the staff of universities, teaching hospitals, research laboratories or similar institutions.

Awards will be made to investigators who are devoting themselves either to the experimental or the clinical aspects of cancer research.

Fellowships will not be granted to persons who wish primarily to perfect their training in methods of cancer detection or in therapeutic techniques, or who wish to visit briefly several institutions abroad. The duration of the fellowships ordinarily will be one year but this period may be longer or shorter in special circumstances.

The stipend will be based on the current salary of the applicant and the salary of comparable qualifications in the place where the applicant expects to study.

An allowance will be made for the cost of

travel of the fellow and of those dependents who will accompany him from his place of residence to the institution where he will work, and return.

Deadline for receiving applications and supporting documents: I September. Successful applicants may begin their Fellowship at any time during the twelve months' period beginning I March.

Application forms and additional information may be obtained from: International Union Against Cancer, P.O. Box 400, 1211 Geneva 2, Switzerland.

### CHEST DISEASE

Interdisciplinary Approach with Emphasis on Radiology

A program on "Chest Disease 1975: Interdisciplinary Approach with Emphasis on Radiology" will be given by the Harvard Medical School Departments of Radiology and Continuing Education at the Copley Plaza Hotel, Boston, Massachusetts, October 13–17, 1975.

The Course Chairman is Herbert L. Abrams, M.D., Philip H. Cook Professor and Chairman of Radiology, Harvard Medical School, Radiologist-in-Chief, Peter Bent Brigham Hospital; Course Director is: Peter G. Herman, M.D., Associate Professor of Radiology, Harvard Medical School, Director, Division of Pulmonary Radiology, Peter Bent Brigham Hospital.

This is an intensive 5 day course designed for radiologists, chest physicians, internists, thoracic surgeons and other practitioners who deal with chest diseases. The aim is to provide a multidisciplinary integrated review of pulmonary abnormalities with special emphasis on the radiologic method. The primary teaching format will be lectures and panel discussions with opportunity for questions. The faculty includes radiologists, chest physicians, pathologists, thoracic surgeons, physiologists and public health specialists both from Harvard Medical School and other institutions.

Major topics will include chronic obstructive airway disease, pulmonary complications in the compromised host. Diagnostic techniques including lung biopsy and use of fiberoptic instruments will be reviewed. Twelve seminars offered at various teaching hospitals will provide an opportunity to get acquainted with the instructors and institutions and to review a topic in detail.

Further information may be obtained from: Associate Dean, Department of Continuing Education, Harvard Medical School, 25 Shattuck Street, Boston, Massachusetts 02115.

### THE YAMAGIWA-YOSHIDA MEMORIAL INTERNATIONAL CANCER STUDY GRANTS

The Yamagiwa-Yoshida Memorial International Cancer Study Grants are supported by funds made available by the Japan National Committee for the UICC. They are administered by the International Union Against Cancer.

They are designed to enable investigators of any nationality to gain experience in, or make comparative studies of, special techniques in both the biological and clinical aspects of cancer research.

These grants are available only for study outside the grantee's country of residence since they are intended to accelerate and encourage international collaborative activities.

The study grants will not be awarded for the purpose of visiting a number of institutes or of solely participating in congresses, conferences, and symposia.

They will be awarded for periods not exceeding 90 days.

Each grantee will receive a travel allowance, equivalent to tourist/economy air fare, and a per diem allowance sufficient to cover board, lodging and incidental expenses; however, no allowance will be paid for dependents.

The closing dates for receipt of applications will be June 30 or December 31 of each year.

Successful applicants will be notified within 90 days of each closing date. Study

Grants must be activated within 180 days of the date of notification.

Application forms and additional information may be obtained from: International Union Against Cancer, P.O. Box 400, 1211 Geneva 2, Switzerland.

### ACR PROFESSIONAL BUREAU

Searching for a position as a radiologist or seeking a suitable candidate can be a frustrating experience without assistance. The American College of Radiology offers such assistance through its Professional Bureau.

The Professional Bureau publishes a list of radiologists seeking positions, and this includes abbreviated resumes, current addresses, and phone numbers. Another list of opportunities for radiologists is published and provides vital information about the type of practice, etc. Radiologists who are within a year of completing their training and are seeking full time radiological positions may obtain a list of opportunities for practice and may be listed in the compilation of registrants seeking positions. Radiologists and other organizations of physicians with positions for full time radiologists may request listing.

Interview services are also provided for registrants of the Professional Bureau at the national radiological meetings. A member of the ACR staff is in attendance at the annual meetings of the American College of Radiology, the American Roentgen Ray Society, the American Society of Therapeutic Radiologists and the Radiological Society of North America.

These services are also available to full time therapists seeking positions and to those offering full time therapy positions. This service is conducted through the American College of Radiology in cooperation with the American Society of Therapeutic Radiologists.

Registration with either the Professional Bureau or the ACR-ASTR joint placement service can be arranged by writing to Mrs. Maureen Haggerty, Director, Professional Bureau, American College of Radiology, 20 North Wacker Drive, Chicago, Illinois 60606.

### BOOK REVIEWS

DIAGNOSIS AND TREATMENT OF PITUITARY TUMORS. Proceedings of a Conference sponsored jointly by the National Institute of Child Health and Human Development and the National Cancer Institute in Bethesda, Md., Jan., 15–17, 1973. Edited by Peter O. Kohler, M.D., Professor of Medicine, Baylor College of Medicine, Houston, Texas; and Griff T. Ross, M.D., Ph.D., Clinical Director, National Institute of Child Health and Development, Bethesda, Md. Cloth. Pp. 343, with some figures. Price, \$36.00. American Elsevier Publishing Company, Inc., 52 Vanderbilt Avenue, New York, N. Y. 10017, 1974.

The reader in search of the latest news on the diagnosis and treatment of pituitary tumors will be amply rewarded in reading this informative little volume. It is printed on good quality demi art paper and the illustrations, with some notable exceptions, are excellent. The typography is clear and the text makes for remarkably easy reading.

The radiologist may not be interested in the endocrine evaluation of pituitary tumors, but the tests are succinctly explained and the information is easy to assimilate. The basic and better known neuroradiologic procedures are discussed leading up to the demonstration of the blood supply of pituitary tumors with impressive magnification subtraction angiography.

The criteria for plain film diagnosis of non-tumorous enlargement of the sella are defined. However, in the final analysis, the diagnosis can only be made by air study. It would be dangerous to assume that a sella were empty when, in fact, it contained a tumor. In the words of one or the contributors, "Since the dismal end results of delay in diagnosis are in such marked contrast to the results of early treatment, the importance of prompt diagnosis and appropriate therapy cannot be overemphasized."

Throughout the book we are enjoined that diagnosis precedes treatment. Angiography complements air studies and biopsy is advised prior to treatment by radiation therapy since cystic tumors respond poorly. It is interesting that at least 2 contributors stated that they had never seen deterioration of visual fields during radiation therapy.

The treatment of pituitary tumors by radiation, heavy particle therapy, surgery, stereotactic surgery and medical management is covered fully but concisely. The reviewer was particularly interested in the treatment of hypersecreting microadenomas (less than 10 mm. in size) by transsphenoidal surgery. It is possible, that we as radiologists have been missing the diagnosis of these small tumors. In this regard, frontal polytomography during encephalography assumes vital importance.

The discussion by the various contributors is remarkably cohesive, except for page 132 where the reviewer felt that something had been omitted

Accounts of conferences are usually only of interest to the contributors and the editors, this volume is clearly an exception.

### H. F. W. Pribram, M.D.

LUPUS ERYTHEMATOSUS: A REVIEW OF THE CURRENT STATUS OF DISCOID AND SYSTEMIC LUPUS ERYTHEMATOSUS AND THEIR VARI-ANTS. Second edition. Edited by Edmund L. Dubois, M.D., Associate Clinical Professor of Medicine, Clinical Immunology and Rheumatic Disease Section, Department of Medicine, University of Southern California School of Medicine; Director of the "Collagen Disease" Clinic, Los Angeles County, University of Southern California Medical Center, Los Angeles, California. Cloth. Pp. 798, with many illustrations. Price \$36.00 plus \$1.50 shipping in U.S. University of Southern California Press, Los Angeles, California 90007, 1974.

The second edition of Dr. Dubois' book is a valuable addition to the library of the internist. On the positive side, it is an excellent and comprehensive clinical account of the disease. The new edition offers the reader the author's extensive and valuable clinical experience with SLE. This book certainly fulfills the need for a single source reference on this important subject. Most of the relevant work done in this field is reviewed in the 2,975 references, which makes this a unique contribution.

Several negative features deserve comment, however. In the chapter on the pathology of

SLE, the rationale behind the name "collagen disease" or "collagen vascular disease" is ably discussed. The undeserved popularity of these terms used by many clinicians indiscriminately and the absence of documented abnormalities in the collagen from these patients are stressed. Finally, the reasonable suggestion is made that if a collective term must be used, connective tissue disease is preferable to collagen disease. It is disappointing that this suggestion was not followed, however, and the text freely uses "collagen disease" in various chapters.

In the opinion of this reviewer, the format adopted of revising the 1965 edition by preserving intact the original chapters and adding supplements, has been unfortunate. The features in favor of this approach are listed in the preface to the second edition. Though it is true that the original chapters have valuable historical content and that a large proportion of the data given is still useful, in some areas more than in others, the information and the interpretations of the facts written more than 10 years ago are not completely accurate or necessary today. Though the supplements are in general very good, there is some sacrifice of space to include the unmodified original chapters. Repetitions are noted in several areas, like Klemperer's views, stated on pages 23 and 236.

Dr. Dubois stresses that discoid LE and SLE are parts of a spectrum of disease and that apparently 10 per cent of all patients who present themselves with typical discoid lesions will eventually develop SLE. Though it is uncertain if this proportion of transitional cases (where DLE becomes SLE) is completely accurate, the text neglects the problem of overdiagnosis; i.e., about 90 per cent of patients with discoid LE never develop SLE. Yet, they become ill many times and each time the ghost of SLE appears, sometimes leading to unnecessary treatment with corticosteroids. The section on management of SLE reflects the authoritative views of the author, and it should be clear to the reader that this is still a very controversial field.

In spite of these objections, the balance is positive and the book is strongly recommended to all physicians interested in any aspect of systemic lupus erythematosus and its relation with discoid lupus and other connective tissue diseases.

FELIX FERNANDEZ-MADRID, M.D.

### **BOOKS RECEIVED**

Radiology of Bone Diseases. Second edition. By George B. Greenfield, M.D., Chairman, Department of Radiology, Mount Sinai Hospital Medical Center, Chicago, Ill.; Attending Radiologist, Cook County Hospital and The Hektoen Institute for Medical Research at Cook County Hospital, Chicago, Ill.; Professor of Radiology, Cook County Graduate School of Medicine, Chicago, Ill.; and Consultant Radiologist, Hines Veterans Administration Hospital, Hines, Ill. Cloth. Pp. 667, with 1,100 illustrations. Price, \$50.00. J. B. Lippincott Company, East Washington Square, Philadelphia, Pa. 19105, 1975.

ROENTGEN DIAGNOSIS OF THE CHEST: A SELF-TEACHING MANUAL. By M. Eiken, M.D., Chief Roentgenologist, Gentofte Hospital, Copenhagen; Consultant Roentgenologist, The Children's Hospital, Fuglebakken, Copenhagen; and Lecturer, Copenhagen University. Paper. Pp. 83, with many illustrations. Price, \$8.95. An F.A.D.L.s FORLAG A.S. publication. Distributed by Year Book Medical Publishers, Inc., 35 E. Wacker Drive, Chicago, Ill. 60601, 1974.

RADIOLOGIC AND OTHER BIOPHYSICAL METHODS IN TUMOR DIAGNOSIS. A Collection of Papers Presented at the Eighteenth Annual Clinical Conference on Cancer, 1973, at the University of Texas System Cancer Center M. D. Anderson Hospital and Tumor Institute, Houston, Texas. Cloth. Pp. 486, with 248 illustrations. Price, \$32.50. Year Book Medical Publishers, Inc., 35 E. Wacker Drive, Chicago, Ill. 60601, 1975.

THE SUPERFICIAL VEINS OF THE HUMAN BRAIN: VEINS OF THE BRAIN STEM AND OF THE BASE OF THE BRAIN. By Henri M. Duvernoy. Cloth. Pp. 110, with 71 figures. Price, \$36.10. Springer-Verlag New York, Inc., 175 Fifth Avenue, New York, N. Y. 10010, 1975.

GAMUTS IN RADIOLOGY: COMPREHENSIVE LISTS OF ROENTGEN DIFFERENTIAL DIAGNOSIS. By Maurice M. Reeder, M.D., Colonel, Medical Corps, United States Army; Chief, Department of Radiology, Walter Reed Army Medical Center; and Radiology Consultant to The Surgeon General, United States Army, Washington, D. C.; formerly, Associate Radiologist, Registry of Radiologic Pathology, Armed Forces Institute of Pathology; and Benjamin Felson, M.D., Professor, Department of Radiology, University of Cincinnati College of Medicine and Medical Center; Consultant to Cincinnati and Dayton Veterans Administration Hospitals; National Consultant to the Medical Corps of the United States Air Force, Army, Navy, and Veterans Administration, United States Public Health Service, Armed Forces Institute of Pathology, and Walter Reed General Hospital. With contributions by Elias G. Theros, M.D., Herbert E. Parks, M.D., and George B. Greenfield, M.D. Cloth. Divided into 8 Sections. Audiovisual Radiology of Cincinnati, Inc., P. O. Box 8942, Cincinnati, Ohio 45208, 1975.

RADIOLOGY OF SYNDROMES. By Hooshang Taybi, M.D., M.Sc., Clinical Professor of Radiology, University of California School of Medicine, San Francisco; Chief, Department of Radiology, Children's Hospital Medical Center, Oakland; Consultant Radiologist, Children's Hospital of San Francisco and Letterman General Hospital, San Francisco. Cloth. Pp. 333, with many illustrations. Year Book Medical Publishers, Inc., 35 E. Wacker Drive, Chicago, Ill. 60601, 1975.

Self-Assessment of Current Knowledge in Therapeutic Radiology. Compiled and Edited by Ned B. Hornback, M.D., Professor and Chairman, Department of Radiation Therapy, Indiana University School of Medicine, Indianapolis, Ind.;

with Homayoon Shidnia, M.D., Vernon E. Leininger, Ph.D., Robert E. Shupe, Ph.D., and Maurice D. Krause, M.D. Paper. Price, \$12.00. Medical Examination Publishing Co., Inc., 65-36 Fresh Meadow Lane, Flushing, N. Y. 11365, 1975.

ATLAS OF TUMOR PATHOLOGY. Second Series, Fascicle 10: TUMORS OF THE MAJOR SALIVARY GLANDS. By A. C. Thackray, M.D., Professor of Morbid Histology, The Bland-Sutton Institute of Pathology, The Middlesex Hospital Medical School, London, England; and R. B. Lucas, M.D., Professor of Oral Pathology, Royal Dental Hospital of London, School of Dental Surgery. Paper. Pp. 144, with some illustrations. Price, \$8.85. Published by the Armed Forces Institute of Pathology, Washington, D. C. For sale by the American Registry of Pathology, Armed Forces Institute of Pathology, Washington, D. C. 20306, 1974.



### SOCIETY PROCEEDINGS

### MEETINGS OF RADIOLOGICAL SOCIETIES\*

### United States of America

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. James Franklin Martin, 300 S. Hawthorne Rd., Winston-Salem, N. C. 27103. Annual Meeting: Marriott Hotel, Atlanta, Ga., Sept. 30-Oct. 3, 1975. AMERICAN RADIUM SOCIETY

AMERICAN RADIUM SOCIETY

Secretary, Richard H. Jesse, Dept. of Surgery, M. D.
Anderson Hosp. and Tumor Institute, Houston, Tex.
77025. Annual Meeting: Americana Hotel, San Juan,
Puerto Rico, May 4-9, 1975.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. Theodore A. Tristan, Harrisburg, Pennsyl-

Verretary, Dr. I neodore A. I ristan, Harrisburg, Pennsylvania. Annual Meeting: McCormick Place on the Lake, Chicago, Ill., Nov. 30-Dec. 5, 1975.

American College of Radiology

Executive Director, William C. Stronach, 20 N. Wacker Drive, Chicago, Ill. 60606. Annual meeting: Portland-Hilton Hotel, Portland, Oregon, March 31-April 4, 1975.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION Secretary, Dr. Antolin Raventos, Davis, Calif. Annual Meeting: Atlantic City, N. J., June 15-19, 1975.

American Board of Radiology
Secretary, Dr. C. Allen Good. Correspondence should be

directed to Kahler East, Rochester, Minn. 55901.
Written Examination will be held in 14 selected sites,

June 21, 1975.

Oral examinations will be held: Pittsburgh Hilton, Pittsburgh, Pa., June 2-7, 1975; Statler Hilton, Dallas, Texas, Dec. 8-13, 1975; Marriott Motor Hotel, Chicago, Ill., June 14-19, 1976; Sheraton Biltmore, Atlanta, Ga., Dec. 6-11, 1976.

Applications must be received in the Board Office before Sept. 30 of the year preceding the one in which the candidate wishes to be examined.

Deadline for filing applications for any examination in

1976 is September 30; 1975.
American Board of Nuclear Medicine, Inc. A Conjoint Board of the American Boards of Internal Medicine, Pathology and Radiology and sponsored by the Society of Nuclear Medicine.

Application forms and further information are avail-

able from the American Board of Nuclear Medicine, 305 E. 45th St., New York, N. Y. 10017.

AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE Secretary, Dr. Robert G. Waggener, Dept. Radiol., Univ. Tex. Health Sciences Center, San Antonio, Tex. 78284.

Annual Meeting, Aug. 3-7, 1975.

American Society of Therapeuric Radiologists

Secretary, Dr. Robert W. Edland, 1836 South Ave., La

Crosse, Wis., 54601. Annual Meeting: Hyatt Regency
Hotel in the Embarcadero Center, San Francisco,
Calif., Oct. 8-12, 1975.

AMERICAN NUCLEAR SOCIETY

Program Chairman, Werner K. Kern; IRD, Space Nuclear Systems, F 309, U. S. Atomic Energy Commission, Washington, D.C. 20545.

American Institute of Ultrasound in Medicine Secretary, John M. Reid, Ph.D., 556 18th Ave., Seattle, Wash. 98122. Annual Meeting.

American Society of Neuroradiology

Secretary, Dr. David O. Davis, Department of Radiology, 901 Twenty-third St., N.W., Washington, D. C. 20037. Annual Meeting.

FOURTEENTH INTERNATIONAL CONGRESS OF RADIOLOGY Rio de Janeiro, Brazil, Oct. 23-29, 1977.

President Elect: Prof. Dr. Nicola C. Caminha; General Secretary: Dr. Durval Couto. Av. Churchill, 97-50 and-LC-39 20,000 Rio de Janziro, Brazil.
International Society of Radiology

Hon. Secretary-Treasurer, Prof. W. A. Fuchs, M.D., Department of Diagnostic Radiology, University Hospital, Inselspital, CH-3010 Bern, Switzerland.

ELEVENTH INTER-AMERICAN CONGRESS OF RADIOLOGY Counselor for the United States, Dr. Juan A. del Regato, Univ. of South Florida, College of Medicine, Tampa, Fla.

Secretary of Congress, Dr. Alberto Mejia, Apartado Aéreo 53737, Bogotá 2, Colombia. Meeting: Feb. 16–21, 1975. NTER-AMERICAN COLLEGE OF RADIOLOGY

President, Dr. Miguel Dao y Dao, Apartado Postal 14213, Candelaria, Caracas, Venezuela, S.A. Secretary of Congress: Dr. Alberto Mejia, Apartado Aéreo 53737, Bogotá 2, Colombia, S.A. Meeting: Bogotá, Colombia, Feb. 16-21, 1975.

THIRD CONGRESS OF THE EUROPEAN ASSOCIATION OF

RADIOLOGY

Secretary-General, P.O. Box 14, 79 Lauriston Place, Edinburgh BHI IDB, Scotland, Meeting: June 22-27, 1975.
SECOND ASIAN AND OCEANIAN CONGRESS OF RADIOLOGY

Secretary, Dr. Buenaventura U. V. Angtuaco, Congress Secretariat Headquarters, 2161 Taft Ave., Manila, Philippines. Meeting: Manila, Philippines, Nov. 10–14, 1975. ALABAMA CHAPTER OF ACR

Secretary-Treasurer, Dr. Lawrence E. Fetterman, Secretary-Treasurer, Dr. Lawrence E. Fetterman, 1720
Springhill Ave., Suite 201, Mobile, Ala. 36604. Meets
time and place of Alabama State Medical Association.
Alaska Radiological Society, Chapter ACR
Secretary-Treasurer, Dr. Maurice J. Coyle, 3200 Providence Ave., Anchorage, Alaska 99504.
American Ostropathic College of Radiology

Annual Scientific Meeting: Americana Hotel, Bar Harbor, Fla. Program Administrator: Lawrence J. Jordan, D.O.,

Suite 21, Ponce American Bldg., 4601 Ponce de Leon Blvd., Coral Gables, Fla. 33146. American Thermographic Society

Secretary-Treasurer, John Wallace, Ph.D., Dept. Radiol., Thomas Jefferson Univ. Hosp., Philadelphia, Pa. 19107. Annual Meeting.

ARIZONA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Robert J. Johnson, 1603 N. Tucson Blvd., Tucson 85716. Two regular meetings a year. Annual meeting at time and place of State Medical Association

and interim meeting six months later.

ARK-LA-TEX RADIOLOGICAL SOCIETY

Secretary, Dr. Erich K. Lang, Confederate Memorial Medical Center, LSU School of Medicine, Shreveport, La. 71101.

ARKANSAS CHAPTER OF ACR

Secretary-Treasurer, Dr. David H. Newbern, 4301 W. Markham, Little Rock, Ark. 72205. Meets twice annually, the Spring Meeting being in conjunction with and at the place of the State Medical Association.

Association of University Radiologists Secretary-Treasurer, Dr. Mark M. Mishkin. The Graduate Hosp., Univ. of Pennsylvania, Philadelphia, Pa. 23rd Annual Meeting: San Diego, Calif., May 4-6, 1975.

ATLANTA RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Marshall J. Cantanzaro, Dept. of Radiol., Northside Hosp., Atlanta, Ga. 30342. Meets on fourth Thursday evenings during the academic year at a

<sup>\*</sup> Secretaries of societies are requested to send timely information promptly to the Editor.

time announced in early September of each year, at the Academy of Medicine, Atlanta, Ga., at 8:00 P.M. BAVARIAN-AMERICAN RADIOLOGIC SOCIETY

Secretary, Maj. Marco J. DiBiase, M.D., Radiology Service, 130 Station Hosp., APO N. Y. 09102. Next Meeting: Berlin, March 14-16, 1975.

BLOCKLEY RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. William H. Green, 616 East 24th

St., Chester, Pa. 19013.

BLUEGRASS RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Eugene Slusher, Lexington Clinic, 1221 S. Broadway, Lexington, Ky. 40504. The Society meets once each month during the school year. BRONX RADIOLOGICAL SOCIETY, NEW YORK STATE, CHAP-

TER ACR

Secretary-Treasurer, Dr. Leon J. Corbin, 1369 Rosendale Ave., Bronx, N. Y. 10472. Meets 4 times a year.

BROOKLYN RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Joshua A. Becker, Downstate

Medical Clin., 450 Clarkson Ave., Brooklyn, N. Y. 11203.

Meets first Thursday of each month, October through June. BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. George J. Alker, Jr., E. J. Meyer Mem. Hosp., Buffalo, N. Y. 14215. Meets second Monday evening each month, October to May inclusive, at University Club.

CALIFORNIA RADIATION THERAPY ASSOCIATION
Secretary-Treasurer, Dr. Duane J. Gillum, Stanford Medical Center, Stanford, Calif. 94304. Meets semiannually in San Francisco and Los Angeles.

CALIFORNIA RADIOLOGICAL SOCIETY, CALIFORNIA CHAPTER

Secretary-Treasurer, Dr. John L. Gwinn, 4650 Sunset Blvd., Los Angeles, Calif. 90027. CATAWBA VALLEY RADIOLOGICAL SOCIETY

Secretary, Dr. Walter Joe Jacumin, P.O. Box 265, Rutherford College, N. C. 28671. Meets the last Thurs-day of every month, Holiday Inn, Morganton, N. C. at 7:30 P.M

CENTRAL NEW YORK RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Alfred Brettner, Auburn Mem. Hosp., Auburn, N. Y. 13021. Meets first Monday each month October through May.

CENTRAL OHIO RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Daniel E. Lewis, Grant Hosp.; Columbus, Ohio 43215. Meets second Thursday in October, November, January, and March 15, and May 19 at Fort Hayes Hotel, Columbus, Ohio.

CENTRAL TEXAS RADIOLOGY SOCIETY Secretary-Treasurer, Dr. John M. Stoebner, Scott and White Clinic, Temple, Tex. 76501. Meets the fourth Monday of each month at Ponderosa Hotel, Temple,

Tex. at 7:00 р.м. CHICAGO RADIOLOGICAL SOCIETY, DIVISION OF THE ILLINOIS RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Harold J. Lasky, 55 E. Washington St., Suite 1735, Chicago, Ill. 60602. Meets third Thursday of each month, October to April, except December, at the Bismark Hotel, Chicago, Ill.

CLEVELAND RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Charles M. Greenwald, 7007
Powers Blvd., X-Ray Dept., Parma, Ohio 44129. Meetings at 7:00 P.M. on fourth Monday of October, November, January, February, March and fifth Monday of April.
Colorado Radiological Society, Chapter of ACR Secretary, Dr. Jerome D. Sutherland, 3705 E. Colfax Ave., Denver, Colo. 80206. Meets third Friday of each month at Denver Athletic Club from September through

Connecticut Valley Radiologic Society Secretary, Dr. Gerald N. LaPierre, 759 Chestnut St., Springfield, Mass. 01107. Meets in April and October. Dallas-Fort Worth Radiological Society

Secretary-Treasurer, Dr. Robert R. Burns, 1400 Stemmons Ave., Dallas, Tex. 75208. Meets the 3rd Monday

of every month at 6:30 P.M., at the Airport Hotel, Arling-

DELAWARE CHAPTER OF ACR

Secretary, Dr. Seymour R. Kaplan, Kent Gen. Hosp., Dover, Del. 19901.

EAST BAY RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Robert L. Stein, 43 Dormidera Ave., Piedmont, Calif. 94611. Meets first Thursday each month, Oct. through May, at University Club, Oakland,

EAST TENNESSEE RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. George H. Wood, 205 Medical Arts Bldg., Knoxville, Tenn. 37902. Meets in January and September.

FLORIDA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary. Dr. Paul J. Popovich, 1350 S. Hickory St., Melbourne, Fla. 32901. Meets twice annually, in the spring with the Annual State Society Meeting and in the fall.

FLORIDA WEST COAST RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Herbert Johnson, Davis Blvd., Tampa, Fla. 33606. Meets on 4th Thursday of the months January, March, May, October, and November. GEORGIA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. E. P. Rasmussen, Piedmont Prof. Bldg., 35 Collier Rd., N.W., Atlanta, Ga. 30309.

GREATER CINCINNATI RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Owen L. Brown, 2421 Auburn Ave., Cincinnati, Ohio 45219.

GREATER KANSAS CITY RADIOLOGICAL SOCIETY President-Secretary, Dr. Keith W. Gallehugh, Bethany Med. Center, Kansas City, Kans. Meets 5 times a year. GREATER LOUISVILLE RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Herbert Johnson, Davis Blvd.,

GREATER LOUISVILLE RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. L. D. LeNeave, 315 E. Broad-

way, Louisville, Ky. 40202. Meets monthly.

GREATER MIAMI RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Robert F. Conti, Holy Cross
Hosp., Fort Lauderdale, Fla. 33308. Meets monthly, third
Wednesday at 8:00 P.M. at various member hospitals, Miami, Fla.

GREATER ST. LOUIS SOCIETY OF RADIOLOGISTS Secretary-Treasurer, Dr. Donald Callahan, Northland

Med. Bldg., Jennings, Mo. 63136.

Hawaii Radiological Society, Chapter of ACR

Secretary-Treasurer, Dr. Sidney B. W. Wong, Straub
Clinic and Hosp., Honolulu, Hawaii 96813. Meets third Monday of each month at 7:30 P.M. HEALTH PHYSICS SOCIETY

Secretary, Russell F. Cowing, P.O. Box 156, E. Weymouth, Mass. 02189. Annual Meeting.

HOUSTON RADIOLOGICAL SOCIETY HOUSTON RADIOLOGICAL SOCIETY

Secretary, Dr. Neill B. Longley, 6436 Fannin, Suite 601,
Houston, Tex. 77025. Meets fourth Monday of each
month, except June, July, August and December, at 6:00
P.M., at 103 Jesse H. Jones Library Building, Texas
Medical Center, Houston, Tex. 77025.

IDAHO STATE RADIOLOGICAL SOCIETY, CHAPTER OF ACR
Secretary-Treasurer, Dr. John H. Truksa, 1605 Park Ave.,
Nampa, Id. 83651. Meets in the spring and fall.

ILLINOIS RADIOLOGICAL SOCIETY, INC., CHAPTER OF ACR
Secretary, Dr. Robert D. Dooley, Hinsdale Med. Center, Hinsdale, Ill. 60221. Meets in the spring and fall.

ter, Hinsdale, Ill. 60521. Meets in the spring and fall.
INDIANA ROENTGEN SOCIETY, INC., CHAPTER OF ACR
Secretary, Dr. John A. Knote, 716 Carrolton Blvd.,
West Lafayette, Ind. 47906.
IOWA RADIOLOGICAL SOCIETY, CHAPTER OF ACR

Secretary-Treasurer, Dr. John Huston, Jr., 1948 First Ave., N.E., Cedar Rapids, Iowa 52402. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific session is held in the

ACTUMN.

KANSAS RADIOLOGICAL SOCIETY, CHAPTER OF ACR

Secretary-Treasurer, Dr. Ralph H. Baehr, 310 Medical

Arts Bldg., Topeka, Kan. 66604. Meets in spring with

State Medical Society and in winter on call.

KENTUCKY CHAPTER OF ACR Secretary-Treasurer, Dr. Bernard Sams, St. Joseph Infirmary, 735 Eastern Parkway, Louisvile, Ky. 40217. Meets in April and September.

KINGS COUNTY RADIOLOGICAL SOCIETY Secretary, Dr. Sidney Hendler, 1880 Ocean Ave., Brooklyn 30, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

KNOXVILLE RADIOLOGICAL SOCIETY Secretary, Dr. Clifford L. Walton, Blount Professional Bldg., Knoxville 20, Tenn. Meetings are held the third Monday of every other month at the University of Tennessee Memorial Research Center and Hospital.

LONG ISLAND RADIOLOGICAL SOCIETY Secretary, Dr. Bruce Saxe, 1200 Stewart Ave., Garden City, N. Y. 11533. Meets monthly.

Los Angeles Radiological Society Secretary, Dr. Isaac Sanders, 1429 Valley View Rd. 13, Glendale, Calif. 91202. Meets second Wednesday of month in September, November, January, April and June at Los Angeles County Medical Association Building, Los Angeles, Calif. Midwinter Radiological Conference. Century Plaza Hotel, Los Angeles, Calif.

LOUISIANA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Roger H. Tutton, 1514 Jefferson Hwy., New Orleans, La. 70121.

LOUISIANA-TEXAS GULF COAST RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Arnold G. Manske, P.O. Box 3008, Port Arthur, Tex. 71670.

MAINE RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Richard W. Taylor, Radiology Department, St. Mary's General Hospital, Lewiston, Maine 04240. Meets in June, September, December and

MARYLAND RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. David S. O'Brien, Anne Arundel Hosp., Annapolis, Md. 21401.

MASSACHUSETTS RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Joseph T. Ferrucci, Jr., Massachusetts Gen. Hosp., Boston, Mass. 02114.

MEMPHIS ROENTGEN SOCIETY Secretary-Treasurer, Dr. Thomas P. Coburn, The University of Tennessee College of Medicine, Department of Radiology, Walter C. Chandler Bldg., 865 Jefferson Ave., Memphis, Tenn. 38163. Meets first Monday Oct. through May at the University Club.

MIAMI VALLEY RADIOLOGICAL SOCIETY
Secretary, Dr. Bert Must, I.B.M. Bldg., Dayton, Ohio.
Meets third Thursday of fall, winter and spring months
at 7:30 P.M. at Miami Valley Hospital, Dayton, Ohio.

MICHIGAN RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Francis P. Shea, Harper Hospital, 3825 Brush St., Detroit, Mich. 48201. Meets monthly, first Thursday, October through May, at David Whitney House, 1010 Antietam, at 6:30 p.m.

MICHIGAN SOCIETY OF THERAPEUTIC RADIOLOGISTS Secretary-Treasurer, Dr. Delmar Mahrt, William Beaumont Hosp., Detroit, Mich. 48072. Meets bi-monthly during the academic year.

MID-HUDSON RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. William D. Stiehm, 37 Flower Hill Rd., Poughkeepsie, N. Y. 12603. Meets 7:00 P.M., first Wednesday of each month, September to May.

MILWAUKEE ROENTGEN RAY SOCIETY Secretary-Treasurer, Dr. Thomas C. Lipscomb, 1004 North Tenth St., Milwaukee, Wis. 53233. Meets monthly on fourth Monday, October through May, at University

MINNESOTA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Marvin E. Goldberg, Box 292, Mayo Memorial Health Sciences Center, Minneapolis, Minn. 55455.

MISSISSIPPI STATE RADIOLOGICAL SOCIETY, CHAPTER OF ACR

Secretary-Treasurer, Dr. Edward L. Gieger, 969 Lakeland Dr., Jackson, Miss. 39216. Meets third Thursday, excluding summer months, at the Primos Northgate Rest., Jackson at 6:30 P.M.

MISSOURI RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Ronald G. Evens, Mallinckrodt Institute of Radiology, 510 S. Kingshighway, St. Louis,

MONTANA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. C. H. Agnew, Room 102, Doctors Bldg., Billings, Mont. 59101.

NEBRASKA CHAPTER OF ACR Secretary-Treasurer, Dr. Robert Bodmer, Suite 622 Doctors Bdg., Omaha, Neb. 68131. Meets the third Wednesday of the month, Oct. through March, at the Clarkson Hosp., Omaha, Neb. and the fourth Friday of April at the Lincoln Country Club, Lincoln, Neb.

NEVADA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Charles F. Veverka, Carson Tahoe Hosp., Carson City, Nev. 89701.

N.E. SOCIETY FOR RADIATION ONCOLOGY Secretary, Dr. C. C. Wang, Mass. Gen. Hosp., Boston, Mass. 02114.

NEW ENGLAND ROENTGEN RAY SOCIETY Secretary, Dr. Melvin E. Clouse, 185 Pilgrim Rd., Boston, Mass. 02115. Meets the third Friday of each month, October through April, excluding December, at The Longwood Towers, 20 Chapel Street, Brookline, Mass. at 3:00 P.M. Annual Meeting: May 16, 1975.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY, CHAPTER OF

Secretary-Treasurer, Dr. Edward P. Kane, Claremont Gen. Hosp., Claremont, N. H. 03743. Meets rour to six times yearly.

New Mexico Society of Radiologists, Chapter of ACR Secretary, Dr. W. M. Jordan, 1100 Central Ave. S.E., Albuquerque, N. M. 87106. Four meetings annually, three held in Albuquerque, N. M., and one held at time and place of New Mexico State Medical Society annual meeting.

NEW ORLEANS RADIOLOGICAL SOCIETY, INC. Secretary-Treasurer, Dr. Jimmy L. Mains, P.O. Box 446, Gretna, La. 70053. Meets bimonthly at local restaurants selected by the President. Spring Conference. New York Roentgen Society

Secretary-Treasurer, Dr. Thomas C. Beneventano, 110 East 210th St., Bronx, N. Y. 10467. Meets monthly on the 3rd Monday at the New York Academy of Medicine Hotel, New York, N. Y., April 24-26, 1975, A.M.A. Cat. I credit. Further information may be obtained from Dr. Albert A. Dunn, Roosevelt Hosp., New York, N. Y.

NEW YORK STATE CHAPTER OF ACR Secretary-Treasurer, Dr. Albert F. Keegan, 6 Secor Dr.,

Port Wash., N. Y. 11050.

North American Society of Cardiac Radiology
Secretary-Treasurer, Dr. Erik Carlson, Univ. Calif.,
San Francisco, Calif. 94143.

North Carolina Chapter of ACR

Secretary-Treasurer, Dr. Ernest B. Spangler, Wesley Long Hosp., Greensboro, N. C. 27402. Meets twice a year. The Spring Meeting is held at the time of the meeting of the North Carolina Medical Society. The Fall Meeting is held in November at the Mid Pines Club, Southern Pines,

NORTH DAKOTA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Pablo Ramos, Box 1618, Bismarck, N. D. 58501. Meets at time of State Medical Association meeting. Other meetings arranged on call of the President.

NORTH FLORIDA RADIOLOGICAL SOCIETY Secretary, Dr. David F. Bew, University Hospital of Jacksonville, 655 W. Eighth Street, P.O. Box 2751, Jacksonville, Fla. 32203. Meets quarterly in March, June, September and December.

Northeastern Oklahoma Radiological Society Secretary-Treasurer, Dr. Theodore J. Brickner, Jr., 5919

S. Gary Place, Tulsa, Okla. 74110. Northeastern New York Radiological Society Secretary, Dr. Donald R. Morton, Dept. of Radiology, St. Clare's Hosp., Schenectady, N. Y. 12304. Meets in Albany area on third Wednesday of October, November, March, April, and May.
Northern California Radiation Therapy Association

Secretary-Treasurer, Dr. John D. Earle, Stanford Medical Center, Stanford, Calif. 94304. Meets quarterly. Northern California Radiological Society

Secretary, Dr. Mark D. Reiss, 5301 F Street, Sacramento, Calif. 95819. Meets on the fourth Monday of Sept., Nov., Jan., March and May at the Mansion Inn, Sacramento, Calif.

NORTHWESTERN NEW YORK RADIOLOGICAL SOCIETY Secretary, Dr. Barbara E. Chick, Glens Falls Hospital, Glens Falls, N. Y. 12801.

NORTHWESTERN OHIO RADIOLOGICAL SOCIETY Secretary, Dr. Richard W. Siders, 421 Michigan, Toledo,

Ohio 43624. Meets 3rd Wednesday from September to

Ohio State Radiological Society, Chapter of ACR Secretary, Dr. Tearle L. Meyer, 175 S. Merkle Rd., Columbus, Ohio 43215.
OKLAHOMA STATE RADIOLOGICAL SOCIETY, CHAPTER OF

Secretary, Dr. George H. Ladd, 4616 Denison, Muskogee, Okla. 74401. Meets in January, May and October.
ORANGE COUNTY RADIOLOGICAL SOCIETY

Secretary, Dr. William E. Danko, 2601 E. Chapman, Orange, Calif. 92667. Meets on fourth Tuesday of the month, excluding June, July, August, and December, at Orange County Medical Association Bldg., Orange, Calif

OREGON STATE RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Robert E. Craven, P.O. Box 12542, Portland, Ore. 97212. Meets on second Wednesday of month, October through April, at the University Club, Portland, Ore.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans, La. 70113. Meets second Tuesday of each

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Betty J. Wood, Dept. of Radiol.,

Vancouver General Hosp., Vancouver 9, B. C., Canada. Annual Meeting.

PENNSYLVANIA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Robert B. Funch, Germantown Hosp.,

Philadelphia, Pa. 19144.

Philadelphia Roentgen Ray Society

Secretary, Dr. Marvin E. Haskin, 230 N. Broad St.,
Philadelphia, Pa. 19102. Meets first Thursday of each
month at 5 P.M., from October to May in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY Secretary, Dr. Klaus M. Bron, Presbyterian-Univ. Hosp. Pittsburgh 15213. Meets second Wednesday of month, September through May, at the Pittsburgh Athletic As-

RADIATION RESEARCH SOCIETY

Executive Secretary, Richard J. Burk, Jr., 4211 39th St., N.W., Washington, D. C. 20016. Annual Meeting. RADIOLOGICAL SOCIETY OF CONNECTICUT, INC., CHAPTER

or ACR Secretary-Treasurer, Dr. Mehdi S. Eslami, 1389 W. Main St., Waterbury, Conn. 06708.

RADIOLOGICAL SOCIETY OF GREATER CINCINNATI Secretary-Treasurer, Dr. Alvin Nathan, c/o Academy of Medicine, 320 Broadway, Cincinnati, Ohio 45202. Meets first Monday of each month at Cincinnati Academy of

RADIOLOGICAL SOCIETY OF NEW JERSEY, CHAPTER OF ACR Secretary, Dr. Sidney Ketyer, St. Elizabeth Hosp., 225 Williamson St., Elizabeth, N. J. 07207. Meets in Atlantic City at time of State Medical Society meeting and in October or November in Newark, N. J

RADIOLOGICAL SOCIETY OF RHODE ISLAND, CHAPTER OF ACR Secretary-Treasurer, Dr. Daniel J. Alves, Rhode Island Hosp., Providence, R. I. 02902.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA Secretary-Treasurer, Dr. A. Franklin Turner, LAC-USC Medical Center, Room 3418, 1200 North State St., Los Angeles, Calif. 90033. Meets three times a year, usually October, February and May.

RADIOLOGICAL SOCIETY OF THE STATE OF NEW YORK

Secretary-Treasurer, Dr. John W. Colgan, 273 Hollywood Ave., Rochester, N. Y. 14618.

REDWOOD EMPIRE RADIOLOGICAL SOCIETY
Secretary, Dr. Charles E. Carter, 121 Sotoyome St.,
Santa Rosa, Calif. 95405. Meets second Monday every other month other month.

RICHMOND COUNTY RADIOLOGICAL SOCIETY Secretary, Dr. Donald P. King, 218 Gun Club Rd., Richmond, Va. 23221. Meets first Thursday of each month at various hospitals.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y. Secretary-Treasurer, Dr. Robert J. Bruneau, 1441 East Ave., Rochester, N. Y. 14610. Quarterly meetings on the call of the President, at the Rochester Academy of Medicine.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Lorenz R. Wurtzebach, 4200 E. Ninth Ave., Denver, Colo. 80220. Annual meeting: Brown Palace Hotel, Denver, Colo., Aug. 21-23, 1975. SAN ANTONIO-CIVILIAN MILITARY RADIOLOGICAL SOCIETY

Secretary, Dr. James R. Stewart, Oak Hills Medical Ctr., San Antonio, Tex. 78209. Meets third Wednesday of each month at Fort Sam Houston Officers Club at 6:30 P.M.

SAN DIEGO RADIOLOGICAL SOCIETY

President, Dr. Stanley G. Seat, 476 Prospect St., La Jolla,
Calif. 92037. Meets the first Wednesday of each month at the University Club.

SAN FRANCISCO RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Charles A. Gooding, Univ. of Calif. Med. Ctr., San Francisco, Calif. 94122.
SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. William H. Graham, 630 East Santa Clara St., San Jose, Calif.

SECTION ON RADIOLOGY, MEDICAL SOCIETY OF THE DIS-TRICT OF COLUMBIA

Secretary-Treasurer, Dr. Albert M. Zelna, 21 Masters St., Potomac, Md. 20854. Meets at Medical Society Library, third Wednesday of January, March, May and October at 8:00 P.M.

SECTION OF RADIOLOGY, NATIONAL MEDICAL ASSOCIATION Secretary, Dr. Ruby Brooks, Dept. Radiol., Veterans Adm. Hosp., P.O. Box 511, Tuskogee, Ala. 36083. Annual

Section on Radiology, Southern Medical Association Secretary, Dr. Mario A. Calonje, 1514 Jefferson Highway,

New Orleans, La. 70121. Annual Meeting.
Section on Radiology, Texas Medical Association
Secretary, Dr. George F. Crawford, St. Elizabeth Hospital, Beaumont, Tex. Meets annually with the Texas Medical Association.

SHREVEPORT RADIOLOGICAL CLUB Secretary, Dr. W. R. Harwell, 608 Travis St., Shreveport, La. Meets monthly on third Wednesday at 7:30 P.M., September to May inclusive.

Society for Pediatric Radiology
Secretary-Treasurer, Dr. John P. Dorst, 601 N. Broadway, Baltimore, Md. 21205. Annual meeting: Marriott Hotel, Atlanta, Ga., Sept. 28-29, 1975.

Society of Gastro-intestinal Radiologists

Society of Gastro-Intestinal Radiologists

Secretary-Treasurer, Dr. John R. Amberg, University
Hospital, 225 W. Dickinson St., San Diego, Calif. 92103.

Society of Nuclear Medicine

Secretary, Dr. E. James Potchen, Edward Mallinckrodt
Institute of Radiology, 660 S. Euclid Ave., St. Louis,
Mo. 63110. Administrative Officer, Mrs. Margaret Glos,
211 E. 437d St., New York, N. Y. 10017. Annual Meeting.

South Bay Radiological Society

Secretary, Dr. Robert Mindalaun, Valley Radiologists

Secretary, Dr. Robert Mindalzun, Valley Radiologists, Inc., 100 O'Connor Dr., San Jose, Calif. 95128. Meets the 2nd Monday of each month at the Santa Clara County Medical Society Bldg., 700 Empey Way, San Tanana and Santa Clara County Medical Society Bldg., 700 Empey Way, San Tanana and Santa Clara County Medical Society Bldg., 700 Empey Way, San Tanana and Santa Clara County Medical Society Bldg., 700 Empey Way, San Tanana and Santa Clara County Medical Society Bldg., 700 Empey Way, San Tanana and Santa Clara County Medical Society Bldg., 700 Empey Way, San Tanana and Santa Clara County Medical Society Bldg., 700 Empey Way, San Tanana and Santa Clara County Medical Society Bldg., 700 Empey Way, San Tanana and Santa Clara County Medical Society Bldg., 700 Empey Way, San Tanana Clara Clara County Medical Society Bldg., 700 Empey Way, San Tanana Clara Clara Clara Clara Clara Clara County Medical Society Bldg., 700 Empey Way, San Tanana Clara Jose, Calif.

South Carolina Radiological Society, Chapter of ACR Secretary, Dr. George W. Brunson, 1406 Gregg St., Columbia, S. C. Annual meeting (primarily business) in conjunction with the South Carolina Medical Association meeting in May. Annual fall scientific meeting at

tion meeting in May. Annual fall scientific meeting at time and place designated by the president.

SOUTH COAST RADIOLOGICAL SOCIETY CHAPTER OF ACR Secretary-Treasurer, Dr. Richard T. Love, Santa Barbara Med. Clin., 215 Pesetas Lane, Santa Barbara, Calif. 93110. Meets fourth Tuesday of alternate months, Sept., Nov., Jan., March and May.

SOUTH DAKOTA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. M. F. Petereit, 2416 S. Phillips, Sioux Falls, S. D. 57105. Meets in spring with State Medical Society and in fall. Society and in fall.

Southern California Radiation Therapy Association Secretary-Treasurer, Dr. Duane J. Gillum, 250 W. Pueblo St., Santa Barbara, Calif. 93105. Meets quarterly. Southern Radiological Conference

SOUTHERN RADIOLOGICAL CONFERENCE

Secretary-Treasurer, Dr. J. W. Maxwell, P.O. Box 2144

Mobile Ala. 36601. Annual Meeting: Grand Hotel, Point
Clear, Ala., Jan. 31-Feb. 2, 1976.

TENNESSEE RADIOLOGICAL SOCIETY, CHAPTER OF ACR
Secretary-Treasurer, Dr. Charles W. Kimsey, 111 Whitehall Bldg., 960 E. Third St., Chattanooga, Tenn. 37403.

Meets annually at the time and place of the Tennessee
State Medical Association meeting. State Medical Association meeting.

Texas State Radiological Society, Chapter of ACR Secretary, Dr. Francis E. O'Neill, 1128 Nix Prof. Bdg., San Antonio, Tex. 78205.

THE FLEISCHNER SOCIETY

Secretary, Dr. E. Robert Heitzman, State University of New York Upstate Medical Center, Syracuse, N. Y. 13210. Annual Meeting: St. Francis Hotel, San Francisco, Calif., May 28-31, 1975.

TRI-STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Alfred Lessure, Welborne Hosp., Evansville, Ind. 47714. Meets bimonthly on the third Wednesday at Arco Hospitals.

Upper Peninsula Radiological Society

Secretary, Dr. A. Gonty, Menominee, Mich. Meets quar-

Utah State Radiological Society, Chapter of ACR Secretary-Treasurer, Dr. Patrick D. Lester, Dept. Radiol., University of Utah Medical Center, Salt Lake City, Utah 84112. Meets quarterly at Holy Cross Hospital.

Vermont Radiological Society, Chapter of ACR Secretary, Dr. J. Lorimer Holm, R.R. #3, Barre, Vt. 05641.

VIRGINIA CHAPTER OF ACR
Secretary-Treasurer, Dr. Charles P. Winkler, 3500 Kensington Ave., Suite 2-A, Richmond, Va. 23221.
WASHINGTON, D. C., CHAPTER OF ACR

Secretary-Treasurer, Dr. Robert M. Allen, 9312 Convento Terr., Fairfax, Va. 22030.

Washington State Radiological Society, Chapter of

Secretary-Treasurer, Dr. Donald J. Hesch, 3216 N.E. 45th Place, Seattle, Wash. 98105.

WEST VIRGINIA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Andrew W. Goodwin, II, 200

Med. Arts Bldg., Charleston, W. Va. 25301. Meets concurrently with annual meeting of West Virginia State Medical Society, other meetings arranged by program committee.

WESTCHESTER COUNTY RADIOLOGICAL SOCIETY Secretary, Dr. James O. Richardson, Jr., 280 Mamaronek Ave., White Plains, N. Y. 10605. Meets on second Tuesday of October, December, February and May.

WISCONSIN RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. June Unger, Wood VA Hosp., Wood, Wis. 53193. Meets twice a year, May and September.

Wisconsin Society of Therapeutic Radiologists Secretary, Dr. Alvin Greenberg, Radiother. Ctr., Univ. Hospitals, Madison, Wis. 53706. Meets quarterly.

WYOMING RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Ross J. Collie, Box 96, Lander, Wyo. 82520. Meets in fall with State Medical Society and in spring on call of President.

### MEXICO, PUERTO RICO AND CENTRAL AMERICA

Asociación Costarricense de Radiología Secretary, Dr. Rafael Umaña-Umaña, Apartado 8-5340, San José, Costa Rica.

San José, Costa Rica.

Asociacón de Radiólogos de Centro America y Panamá. Comprising: Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panamá Secretary-General, Dr. Francisco Miranbell Solis, Apartado 3352, San José, Costa Rica, Central America. Meets annually in a rotating manner in the six countries.

Asociación Puerrorriqueña de Radiología

Secretary Dr. R. R. Díaz Ronnet, Suita coa Professional

Secretary, Dr. R. B. Díaz Bonnet, Suite 504, Professional Bldg., Santurce, Puerto Rico.

Sociedad de Radiología de Salvador Secretary, Dr. Carlos Meijia, 5a Av. Nte. No. 434, San Salvador, Rep. El Salvador.

Sociedad de Radiología de Guatemala Secretary, Dr. Carlos E. Escobar, 92, Calle A 0-05, Zona 1, Guatemala

Sociedad Mexicana de Radiología, A.C.
Coahuila No. 35, México 7, D.F., México.
Secretary-General, Dr. Jorge Cano Coquí. Meets first Monday of each month.

Sociedad Radiológica Panameña Secretary, Dr. L. Arrieta Sánchez, Apartado No. 6323, Panamá, R. de P. Meets monthly in a department of radiology of a local hospital chosen at preceding meeting.

Sociedad Radiológica de Puerto Rico Secretary, Dr. Heriberto Pagán Sáez, Box 9387, Santurce, Puerto Rico. Meets second Thursday of each month at 8:00 P.M. at the Puerto Rico Medical Association Bldg. in San Juan.

### British Commonwealth of Nations

Association of Radiologists of the Province of **OUEBEC** 21 Boul. Taschereau, Greenfield Park, P. Q., Canada.

Meets four times a year.

BRITISH INSTITUTE OF RADIOLOGY Honorary Secretaries, D. H. Traspnell, M. Cohen, 32 Welbeck St., London, W1M/7PG, England.

CANADIAN ASSOCIATION OF PHYSICISTS, DIVISION OF MED-ICAL AND BIOLOGICAL PHYSICS Honorary Secretary-Treasurer, Dr. R. G. Baker, Ontario Cancer Foundation, Ottawa Civic Clinic, 1053 Carling

Ave., Ottawa 3, Ont., Canada. Canadian Association of Radiologists

Honorary Secretary, Dr. Ross O. Hill, Suite 806, 1440 St. Catherine St. West, Montreal 107, Que., Canada. Thirtyeighth Annual Meeting: Toronto, Ont., May 11–16, 1975.

Edmonton and District Radiological Society Secretary, Dr. L. A. Koller, Suite 360, Professional Bldg., 10830 Jasper Ave., Edmonton 15, Alberta, Canada. Meets third Thursday of each month October to May, except December, at various Edmonton Hospitals.

FACULTY OF RADIOLOGISTS

Honorary Secretary, P. D. Thomson, 28 Portland Pl., London, WIN 4DE.

MONTREAL RADIOLOGICAL STUDY CLUB

Secretary, Dr. W. Paul Butt, Montreal General Hospital, Montreal, Que., Canada. Meets first Tuesday evening, October to April.

Section of Radiology of the Royal Society of Medi-CINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 8:15 P.M. at the Royal Society of Medicine, I Wimpole St., London, W. I M8AE, I England.

Société Canadienne-Française de Radiologie Secretary-General, Dr. Hubert Sasseville, Verdun Hospi-tal, Montréal, P. Q., Canada. Meets every third Tuesday from October to April.

THE HOSPITAL PHYSICISTS' ASSOCIATION

Honorary Secretary, J. B. Massey, B.Sc., Christie Hosp.
and Holt Radium Institute, Physics Department, Withington, Manchester M20 9BX, England.

TORONTO RADIOLOGICAL SOCIETY

Secretary, Dr. George Wortzman, Toronto General Hosp. Toronto 12, Ont., Canada. Meets second Monday of each month, September through May.

THE ROYAL AUSTRALASIAN COLLEGE OF RADIOLOGISTS Honorary Secretary, Dr. T. P. Loneragan, 45 Macquarie St., Sydney, N.S.W. 2000, Australia.

### South America

Colégio Brasileiro de Radiologia Secretary-General, Dr. José Marcos Pires de Oliveira, Caixa Postal 5984, São Paulo, Brazil.

Federación Argentina de Sociedades de Radiología Branches of the Federation are: Sociedad de Radiólogos de la Provincia de Córdoba; Sociedad Argentina de Radiología; Asociación Argentina de Radiología; Sociedad de Radiología, Radioterapéutica y Medicina Nuclear de Rosario; Sociedad de Radiología y Medicina Nuclear del Centro y Sudeste de la Provincia de Buenos Aires (Mar del Plata); Sociedad Salteña de Radiología y Medicina Nuclear; Sociedad de Radiología de Tucumán; Sociedad de Radiologia del Nordeste Argentino; Sociedad de Ra-diología de La Plata; and Sociedad de Radiología de San

Secretary-General-Treasurer, Dr. Roberto Habichayn, Av.

Colón 637, Córdoba, Argentina.

Congress will be organized by Sociedad de Radiología, Radioterapéutica y Medicina Nuclear de Rosario in 1975.

Sociedad Argentina de Radiología Secretary-General, Dr. Tomás J. Gutiérrez F, Santa Fé 1171, Buenos Aires, Argentina. Meets first Wednesday evening, April through December.

Sociedad Boliviana de Radiología

Secretary, Dr. Javier Prada Méndez, Casilla 1182, La Paz, Bolivia. Meets monthly. General assembly once every two years.

Sociedade Brasileira de Radiologia

Secretary, Dr. Armando Rocha Amoédo, Caixa Postal 1532, Rio de Janeiro, Brazil. General Assembly meets every two years in December.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA
Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on
second Wednesday at 9:00 p.m. in São Paulo at Av.
Brigadeiro Luiz Antonio, 644.

Sociedad Chiléna de Radiología

Secretary, Dr. Manuel Neira, Casilla 13426, Santiago, Chile. Meets first Friday of each month at Av. Santa María 1810 at 7:00 P.M.

Sociedad Colombiana de Radiología

Secretary-General, Dr. Gustavo Sánchez Sánchez, Bogotá, Colombia. Meets last Thursday of each month.

Sociedad Ecuatoriana de Radiología Secretary, Dr. Luis Blum, Casilla 3712, Guayaquil, Ecuador.

Sociedad Paraguaya de Radiología

Secretary, Dr. Hugo Volpe Rios, 15 de Agosto 322, Asunción, Paraguay.

Sociedad Peruana de Radiología

Secretary-General, Dra. Ladis Delpino, Av. General Santa Cruz No. 315, Miraflores, Lima, Perú, Casilla Correo, 2306, Lima, Perú. Meets monthly except during January, February, and March.

Sociedad de Radiología del Atlantico Secretary, Dr. Raul Fernandez, Calle 40 #41-110, Baran-quilla, Colombia. Society meets monthly at the Instituto de Radiología.

Sociedad de Radiología del Nordeste Argentino Secretary-General, Dr. Francisco J. Velar, Catamarca 561, Corrientes, Argentina. Sociedad de Radiología de La Plata

Secretary, Dr. Hiram D. Haurigot, Calle 50 No. 374, La Plata, Argentina.

Sociedad de Radiología, Cancerología y Física Médica del Uruguay

Secretary-General, Dr. Manuel Gonzáles Maseda, Av. Agraciada 1464, piso 13, Montevideo, Uruguay. Sociedade de Radiología de Pernambuco

Secretary, Dr. Manoel Medeiros Instituto de Radiologia da Faculdade de Medicina da Universidade do Recife,

Caixa Postal 505, Pernambuco, Brazil. Sociedad de Roentgenología y Medicina Nuclear de la Provincia de Córdoba

Secretary-General, Dr. Lucas C. Di Rienzo, Ave. Grl. Paz. 151, Córdoba, Argentina.

Sociedad de Radiología, Radioterapéutica y Medicina NUCLEAR DE ROSARIO Secretary-General, Dr. Federico Frágola, Santa Fe 1798,

Rosario, Argentina. Sociedad Salteña de Radiología y Medicina Nuclear Treasurer, Dr. Julio Luis Baldi, Av. Sarmiento 536, Salta,

Argentina

Sociedad Venezolana de Radiología y Medicina Nu-CLEAR Secretary-General, Dr. Salvador Itriago Borgas, Apartado Postal 9213, Candelaria, Caracas, Venezuela. Meets monthly, third Friday at Colegio Médico del Distrito Federal, Caracas.

### CONTINENTAL EUROPE

ÖSTERREICHISCHE RÖNTGEN-GESELLSCHAFT Secretary, Dr. Ernst Kotcher, Wiener Allgemeine Poli-klinik Mariannengasse 10, A-1090 Wien, Austria. Meets second Tuesday of each month in Allgemeine Poliklinik.

Société Royale Belge de Radiologie General Secretary, Dr. Joseph Baeyens, Alost, Belgium. Meets in February, March, May, June, September,

October, November and December.

Octoder, November and December.

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# ABSTRACTS OF RADIOLOGIC LITERATURE

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### ROENTGEN DIAGNOSIS

### NECK AND CHEST

CAPELLÁ, BUJOSA G. Estenosis traqueales. (Tracheal stenosis.) An. de med., Aug., 1974, 60, 733-748. (From: Sociedad Catalana de Oto-Rino Laringologia, Barcelona, Spain.)

The tracheal lumen can be narrowed by extrinsic changes (masses or fibrosis) in the neck or mediastinum. Intrinsic stenosis is usually secondary to tracheotomies or relatively prolonged endotracheal intubation, and is due to scarring and/or granuloma formation.

Proper technique and meticulous care during the period of intubation would reduce the incidence of these complications. Prophylactic steroids and antibiotics might be helpful.

Several treatment methods are available: (a) periodic or continuous dilatation, the results are unpredictable; (b) resection of the stenotic segment and end-to-end anastomosis, this can be done if the lesion is less than 3 cm. long; if the lesion is in the thoracic portion of the trachea, mortality is high; and (c) plastic reconstruction.

This article reviews 3 lesions in the cervical trachea, treated with good results using the technique of Aboulker.—Julian B. Alvarez, M.D.

Beguery, P., Douay, B., Rémy, J., and Voisin, C. Exploration radiologique de quelques affections trachéo-bronchiques chroniques rares. (Radiologic study of certain rare chronic tracheobronchial conditions.) Ann. de radiol., Nov., 1974, 17, 649-668. (Address: Dr. P. Beguery, Service central de Radiologie, Hôpital A.-Calmette, 2, avenue Oscar-Lambret, F 59033 Lille Cedex, France.)

Disease of the trachea is relatively rare as compared with the much more frequent bronchial disease. Tracheal disease is often accompanied by bronchial involvement, but the combination of tracheobronchial disease is rare.

The authors report on the radiologic study of several rare tracheobronchial conditions: tracheobronchomegaly, 5; chronic atrophic polychondritis with tracheal manifestations, 1; tracheobronchial chondro-osteoplastic tracheobronchopathy, 4; and diffuse tracheobronchial amyloidosis, 1.

The radiographic examination of the tracheobronchopathies is done with conventional radiography, high voltage radiography, tomography, and tracheobronchography.

I. Tracheobronchomegaly is characterized by significant dilatation due to congenital anomaly of the elastic and muscular tissues of the tracheobronchial tree. Five cases with pertinent history are reviewed with excellent, illustrative roentgenograms.

Tracheobronchomegaly is less frequent than pure

dilatation of the bronchial tree. It occurs most frequently in young people, in the third and fourth decades, although it has been observed in infants and adolescents. It occurs predominantly in the male (72 per cent) and rarely in the female. The cervical trachea is not usually involved.

Tracheobronchomegaly is usually found in a patient presenting manifestations of chronic suppurative bronchial disease. On physical examination, a noisy cavernous, almost boisterous cough is heard. Signs of respiratory insufficiency are of infrequent occurrence.

Plain film on routine radiography, high voltage radiography, bronchography, and tomography reveal marked dilatation of the thoracic trachea and major bronchi, irregularity in the outline of the trachea as well as diverticulation. Endoscopy does not make a significant contribution to the diagnosis.

2. Chronic atrophic polychondritis. This is a systemic disease of unknown cause characterized by regressive and extensive degeneration of cartilage. Thus, involvement of the tracheobronchial cartilaginous tissue is a local manifestation of a systemic disease. This condition involves both sexes with a female preponderance. Age ranges between 30 and 50 years.

The cartilaginous involvement occurs in the ears, nose, in various joints, rarely in the ocular region. However, in the evolution of the disease, all cartilaginous tissues of the body may be involved.

Nasal and ear involvement are accompanied by destruction of cartilage and a resultant deformity. Joint involvement presents a picture which simulates polyarthritis and chronic rheumatoid arthritis. Involvement of the larynx is less frequent than the trachea. Respiratory insufficiency and distress may be striking clinical symptoms. Radiologic examination contributes very little to the diagnosis and fails to demonstrate the softening of the cartilage in the trachea and bronchi.

- 3. Chondro-osteoplastic tracheobronchopathy is a rare condition of unknown origin characterized by the presence of cartilaginous or osseous-cartilaginous submucous plaques, or deposits, in the tracheobronchial system. This is diagnosed best by endoscopy. High voltage radiography and tomography reveal retraction of the tracheobronchial lumen, best demonstrated in the routine frontal projection. Endoscopic study demonstrates more readily the changes in the mucosa and the lumen of the trachea.
- 4. Diffuse primary tracheobronchial amyloidosis is a rare condition characterized by diffuse amyloid infiltration into the submucosa of the trachea and bronchi resulting in retraction and narrowing of the lumen. Radiologic manifestations are those of irregular narrowing, undulation, and thickening of the tracheal and bronchial wall, irregularity in their contour. Tracheobronchography is more helpful than tomography. The lung parenchyma is not involved in amyloidosis. Endoscopy remains the most impor-

tant single modality of examination.

Nineteen excellent reproductions of roentgenograms accompany this presentation.—William H. Shehadi, M.D.

Lander, Philip, and Palayew, Max J. Infectious mononucleosis—a review of chest roentgenographic manifestations. J. Canad. A. Radiologists, Dec., 1974, 25, 303–306. (From: Department of Radiology, Jewish General Hospital & McGill University, Montreal, Quebec, Canada.)

The chest roentgenograms of 59 patients with a clinical and laboratory proven diagnosis of infectious mononucleosis were reviewed.

Distinct hilar adenopathy was present in 4 patients and prominent hila were present in 4 patients. An interstitial reticular pattern within the lung was present in only 3 patients. Three patients had small or moderate pleural effusions. The most frequent roentgenographic finding was splenomegaly, characterized by displacement of the gastric air bubble or splenic flexure in 28 patients, and questionable splenomegaly in 9 patients.

The heterophile antibody test may be negative initially with a rising titer occurring several days or weeks after the clinical and radiologic onset of the disease.—Ronald J. Ross, M.D.

### ABDOMEN

MAGNESS, LINDA J., SANFELIPPO, PETER M., VAN HEERDEN, JONATHAN A., and JUDD, EDWARD S. Diverticular disease of the right colon. Surg., Gynec. & Obst., Jan., 1975, 140, 30–32. (From: The Department of Surgery, Mayo Clinic and Mayo Foundation, Rochester, Minn.)

There is a 0.7 to 1.5 per cent incidence of diverticula of the right colon in all patients with colonic diverticulosis. In a review of a series of 3,874 patients with colonic diverticulosis at the Mayo Clinic, there were only 35 patients with right-sided diverticula, representing a 0.9 per cent incidence. Twenty-seven of these 35 patients had multiple diverticula of the ascending colon and cecum. Eighteen patients had symptoms usually localized to the right lower quadrant. Seven patients had a cecal diverticulum which had perforated. Diverticulitis of the right colon may present as an acute inflammatory process and frequently mimics appendicitis.

Two types of diverticula occur in the right side of the colon. More frequently, the congenital or true diverticulum containing all layers of the intestinal wall is the one present in the cecum and ascending colon and is usually solitary. When the false diverticulum containing only the mucosa and submucosa is present within the ascending colon, there are usually other false diverticula within the left side of the colon. Eighty-eight per cent of the true diverticula occur in the cecal area and the remainder are present in the ascending colon. Right-sided diverticulosis occurs at a younger age, average of 40 years, as compared to patients with left-sided diverticulitis whose ages range from 54 to 63 years average.

The barium enema examination is the only definitive diagnostic aid in right-sided diverticulitis. The intraoperative diagnoses include malignant lesions, appendiceal abscess, solitary ulcer of the cecum, regional enteritis, amebic granuloma, tuberculosis, actinomycosis, and carcinoid.—Ronald J. Ross, M.D.

RECALDE, MARCELO, HOLYOKE, E. DOUGLAS, and ELIAS, ELIAS G. Carcinoma of the colon, rectum, and anal canal in young patients. Surg., Gynec. & Obst., Dec., 1974, 139, 909–913. (From: The Department of General Surgery, Roswell Park Memorial Institute, New York State Department of Health, Buffalo, N.Y.)

Forty patients with carcinoma of the lower intestinal tract (19 females and 21 males) were reviewed retrospectively at the Roswell Park Memorial Institute. All the patients were 35 years of age or less, and patients with polyposis of the colon were excluded. The distribution of the lesions was similar to that seen in the older age group. Interestingly, 21 lesions were found in the anus, rectum or lower sigmoid. Abdominal pain and rectal bleeding were the most common presenting complaints. Surgical findings included a rectal mass (21 patients); abdominal distention (16 patients), and hepatomegaly (3 patients).

Pathologically 38 patients had granular carcinomas and 2 patients had squamous cell lesions. The lesions were resectable in 33 patients and some of the nonresectable lesions required diversion for paliation.

The authors present 4 cases in some detail because of their clinical interest in these cases.

Survival data revealed that 33 patients died in less than 5 years and 23 died in the first 2 years. The survival time can be correlated to the cell type and differentiation. All long-term survivors had well to moderately differentiated adenocarcinomas. Patients with mucin-producing lesions died within 2 years. Lesions greater than 5 cm. in diameter produced death in less than 4 years. There were no 5 year survivors when there were visceral or lymph node metastases. The location of the lesion within the colon did not affect the prognosis.

The authors conclude that lower intestinal carcinoma is rare, but not uncommon in the younger age group. The poorer prognosis which has been mentioned in recent publications probably reflects more a delay in diagnosis than a difference in prognosis per se.

The authors emphasize that rectal bleeding, hem-

orrhoids, change in bowel habits and recurrent abdominal pain in the younger age group should be thoroughly evaluated clinically and radiologically just as in older patients.—Daniel P. Link, M.D.

CHESSICK, KENNETH C., BLACK, SIDNEY, and HOYE, STEPHEN J. Spasm and operative cholangiography. A.M.A. Arch. Surg., Jan., 1975, 110, 53-57. (Address: Kenneth C. Chessick, M.D., 316 S Line Avenue, Inverness, Fla. 32650.)

Spasm of the sphincter of Oddi during operative cholangiography may be secondary to anesthetic agents, morphine sulfate, irritating contrast medium, and operative manipulation during common duct exploration.

The failure to recognize the role of spasm at the sphincter of Oddi may result in further unnecessary surgery with severe morbidity and increased mortality.

The anesthetic agent fentanyl citrate (Sublimaze) was a factor in producing severe spasm of the sphincter of Oddi in 6 cases reported by the authors. There was complete obstruction of the distal common duct on operative cholangiography following thorough common duct exploration. In 3 of these cases there was unnecessary re-exploration of the common duct with increased morbidity. In the other 3 cases, obstruction due to spasm was recognized and no further surgery was done. Postoperative cholangiography in the latter group showed a normal sphincter.

Manipulation during common duct exploration contributed to spasm of the sphincter of Oddi in some of these cases.

Rapid injection of cold or irritating contrast medium is known to produce spasm.

The common duct should not be re-explored if contrast medium fails to flow into the duodenum following common duct exploration and passage of a probe through the sphincter of Oddi, unless there is some obvious filling defect present.

A tapered "bird-beaked" appearance of the terminal common duct is suggestive of spasm.—Paul M. Dassel, M.D.

### GENITOURINARY SYSTEM

CAPRIOLI, GIULIO, and RADAELI, ENRICO. Calcolosi renale liquida: tre nuovi casi. (Milk of calcium renal stone: three new cases.) Radiol. med., Aug., 1974, 60, 670–677. (Address: Dr. Giulio Caprioli, Spedali Civili, 3 piazza Ospedale, I-25100 Brescia, Italy.)

Fresnais in 1937 first described a case of liquid calcium material collected in a pyelogenous cyst and it was Howell in 1969, who coined the term milk of calcium renal stone.

From a review of the literature, the authors found that in 21 cases the milk of calcium was retained in a pyelogenous cyst or in a calyceal diverticulum and only in 4 cases was it collected in a large nephrotic sac. Apparently only in the case reported by Rosenberg (1967) was a communication demonstrated between the cyst containing the liquid calcium material and the collecting system.

The authors report 3 cases of milk of calcium renal stone observed, respectively, in a 55 year old woman, in a 30 year old man, and in a 23 year old woman. In all the cases the liquid calcium material was collected in large hydronephrotic sacs. Only the male patient was subjected to right nephrectomy, with pathologic confirmation of the roentgen diagnosis.—A. F. Govoni, M.D.

MA, MICHAEL KIN GAY, and CHAN, KEENG WAI. Renal angiomyolipoma: report of 5 cases. *Brit. J. Urol.*, Oct., 1974, 46, 481-484 (From: Department of Surgery, University of Hong Kong, Queen Mary Hospital, Hong Kong, Hong Kong.)

Angiomyolipomas are rare tumors affecting the kidneys; they may occur as part of the tuberous sclerosis syndrome. In these patients the lesions are usually bilateral. The angiomyolipomas are hamartomas with no evidence of malignant change. When these lesions occur in patients without the associated systemic changes of tuberous sclerosis, they may mimic a malignant renal lesion and are treated as such.

Five patients with renal angiomyolipomas with no other clinical symptoms other than those related to the tumor are presented. Nephrectomy was performed in all patients because of the clinical symptoms. In all of the 57 cases reviewed in the literature, the clinical symptoms included pain in 73 per cent, hematuria 26 per cent, infection 10 per cent, hypertension 1 per cent, and palpable mass 42 per cent.

The angiolipoma is impossible to differentiate from a neoplasm on routine intravenous and retrograde pyelography. The renal angiogram may be more diagnostic, demonstrating a network of tortuous small vessels which persist for some time with minimal sinusoidal and venous vascularity.—Ronald J. Ross, M.D.

EKELUND, L., and LINDHOLM, T. Angiography in renal amyloidosis. *Acta radiol.*, July, 1974, 15, 393-400. (From: The Department of Diagnostic Radiology and Medical Department B [Renal Unit], University Hospital, S-221 85 Lund, Sweden.)

The authors report their experience with renal angiography in 6 adult patients; 5 of the 6 having renal biopsy proven amyloidosis and the sixth by biopsy of an extrarenal site (rectal mucosa). Four patients had secondary amyloidosis (3 with chronic rheumatoid arthritis, 1 with chronic osteomyelitis)

with the remaining 2 patients having primary renal amyloidosis. One patient presented with acute oliguric renal failure, while all the remaining cases had chronic renal failure of a variable degree (creatinine clearances of 3-65 ml. per minute); additionally, 4 patients had a nephrotic syndrome; however, renal venography or subsequent autopsy excluded renal vein thrombosis as a causative associated lesion.

The characteristic amyloid lesion is vascular involvement with thickening of vessel walls (of any size), especially the glomeruli. These vascular changes reflect the arteriographic findings of a normal main artery, smooth narrowings of segmental branches or tortuosity and irregularity of same, absent filling of cortical branches (interlobular), delayed emptying of arterial vessels and a poorly defined corticomedullary junction. Renal size was basically normal in most, being questionably slightly enlarged in 1 and definitely small in 3; however, 2 of the latter had superimposed hypertension or urinary tract infection. The differential diagnosis includes chronic glomerulone-phritis predominantly, but occasionally chronic pyelonephritis.—*Richard C. Pfister, M.D.* 

Merland, J.-J., Le Guillou, M., Lepage, T., Bories, J., and Kuss, R. Artériographie hypersélective et embolisation en pathologie génito-vésicale chez l'homme: techniques, résultats, indications. (Hyperselective arteriography and embolization in human genito-vesical pathology: techniques, results, indications.) Ann. de radiol., Oct., 1974, 17, 611–627. (Address: Dr. J.-J. Merland, Service de Neuro-Radiologie, Charcot Hôpital de la Salpêtrière, 47, bd. de l'Hôpital F 75634 Paris Cedex 13, France.)

The authors report on their experience with hyperselective arteriography of the branches of the hypogastric artery, and particularly of the genital and vesical arteries, producing embolization of the vessels resulting in hematosis in cases of severe hematuria.

This technique was used in 6 patients with gratifying, immediate, and spectacular cessation of bleeding, which for the most part proved to be lifesaving.

Following identification of the bleeding artery and localization of the point of bleeding, embolization is produced by the application of a gelatin sponge (spongel) to the site of bleeding.

The first case was that of a 25 year old male with severe bleeding due to angiomatosis of the bladder. In the other 5 cases, vesical hematuria was due to postradiation changes and resultant cystitis following cobalt 60 therapy. In 3 patients, the bladder tumor had completely disappeared. In the other 2 patients, the bladder tumor was still present. Additionally, I patient with unusual penile arteriovenous fistula was suffering from severe hemorrhage and was treated in the same manner.

The preferred route of catheterization is through the axillary artery. Downward progression of the catheter is enhanced by the arterial flow in the direction in which the catheter is progressing.

This route should be tried first. It is most successful in the younger age group. The femoral route may be more feasible in older patients in as much as atherosclerotic changes in the aorta may interfere with the downward progress of the catheter introduced through the axillary artery.

Embolization with gelatin sponge (spongel) has been used in the cervical-cephalic and vertebralmedullary areas by the neurosurgeon. The authors believe that this is the first time this technique has been used in the realm of urology.

The authors stress the importance of producing the embolization at the exact site of bleeding and not at a higher level of the bleeding artery. With the latter procedure, bleeding may start again by means of collateral circulation.

Nine figures, each with reproductions of multiple roentgenograms and drawings, accompany this article.—William H. Shehadi, M.D.

Bewick, M., Collins, R. E. C., Saxton, H. M., Ellis, F. G., McColl, I., and Ogg, C. S. The surgery and problems of the ureter in human renal transplantation. *Brit. J. Urol.*, Oct., 1974, 46, 493–510. (From: Guy's Hospital, London, King's College Hospital, The Royal Sussex County Hospital, Brighton, and The Kent and Canterbury Hospital, Canterbury, England.)

The authors summarize the main reported series since 1966 and show that the incidence of complications referable to urinary drainage disorders in renal allotransplantation is between 10 and 20 per cent with an associated mortality of 2–15 per cent.

Urographic Technique. In the second week following transplantation, nephrotomography is routinely performed whether there is evidence of renal function or not. A plain roentgenogram and preliminary tomographic cut are obtained before contrast medium is given. These confirm proper centering and exposure factors. The usual level of tomographic section is at the estimated height of the superior pubic ramus. The standard dose of contrast medium is 100 ml. of sodium iothalamate 70 per cent. In patients with edema or heart failure, 150 ml. of meglumine iothalamate 60% is administered.

A film is exposed at the end of injection to show the initial nephrogram, and at 5 minutes after injection another film is exposed, and 3 tomographic sections are also obtained. The appearances at this stage indicate what further films may be needed. If there is prompt excretion with clear delineation of renal outlines and a normal collection system, then a film at 30 minutes will show the bladder and this then may be followed by a post-micturition film.

When opacification is poor, tomography is essential and additional tomographic cuts either anteriorly or posteriorly may be required. In some cases the pyelocalyceal system is not seen, but the ureter and late bladder opacification will show that contrast medium is being excreted in poor concentration. These changes are usually due to mild calyceal compression by swollen parenchyma.

If no opacification of the collecting system occurs, then delayed films are required up to 24 hours until the diagnosis is clear. A prolonged nephrographic pattern without calyceal filling may be seen in tubular necrosis as well as ureteral obstruction. Occasionally, there will be no evidence of excretion at any stage, not even a nephrogram, and this may indicate arterial obstruction.

The criteria for the presence of ureteral obstruction are similar to those in nontransplanted kidneys—delayed excretion with a delayed onset of a progressively intense nephrogram and calyceal, pelvic, and ureteral distention down to the point of holdup.

Extravasation from an anastomotic site is easy to identify if density is adequate, but may otherwise be difficult. This diagnosis should be entertained, however, when the calyces opacify but contrast media never reaches the urinary bladder.

Early Postoperative Function. In those cases in which there is early production of urine and dialysis is not required, the intravenous urogram with tomography will act as a baseline for subsequent examinations and to ensure that there is no ureteral obstruction.

The Early Anuric Kidney. There are 4 causes for anuria at this stage: vascular thrombosis (arterial or venous); ureteral obstruction; rejection; and acute tubular necrosis. Vascular abnormalities are best shown by the use of an I<sup>131</sup> labeled Hippuran scan or a renal arteriogram. In the authors' hands, the Hippuran scan has given good results, and they normally perform one between the second-tenth postoperative day. If the scan shows no Hippuran uptake, then a renal arteriogram is obtained with the femoral puncture being done on the contralateral side. They have utilized venography in a limited fashion and only when there was gross swelling of the ipsilateral leg.

If by the 15th to 20th postoperative day the kidney is severely oliguric, then a renal biopsy is performed. If blood flow is adequate and rejection unlikely, the anuria is probably due to obstruction or acute tubular necrosis. A prolonged nephrogram with faint or absent opacification of pyelocalyceal system is suggestive of tubular necrosis rather than obstruction.

Failing renal function in a previously "life supporting" transplant kidney occurring within 3 months is usually due to either rejection or obstruction. The causes of obstruction at this stage are: distal ureteral obstruction due to ureteral ischemia; ureteral stenosis or submucosal tunnel hematoma;

clots in the drainage structures; lymphocele; ureteral kinking; and ureteral obstruction due to periureteral abscess formation.

A late failure in renal function occurring some 3 months after satisfactory transplant function may be due to ureteral obstruction from scarring, ureteral rejection and late formation of a lymphocele with ureteral obstruction.—Richard C. Pfister, M.D.

ZINCKE, HORST, KELALIS, PANAYOTIS P., and CULP, ORMOND S. Ureteropelvic obstruction in children. Surg., Gynec. & Obst., Dec., 1974, 139, 873-878. (From: The Department of Urology, Mayo Clinic and Mayo Foundation, Rochester, Minn.)

One hundred and fifty-two children with congenital ureteropelvic obstruction were reviewed at the Mayo Clinic Department of Urology. All patients were under 16 years of age and the male to female ratio was 2:1. Pain was the most common presenting complaint. Frequently the pain was vague abdominal or periumbilical and associated with vomiting. The diagnosis of ureteropelvic obstruction is usually made on excretory urography and the authors prefer an infusion study. Retrograde pyelography is necessary only if the renal function does not allow visualization on excretory studies. Vesico-ureteral reflux is routinely excluded in this series by cystography.

The precise cause of every case is not always found. In some cases there is a redistribution of muscle spirals by longitudinal fibers leading to a narrow aperistaltic segment. In other cases kinks, bands, and external structures at least increase the ureteropelvic junction obstruction in children. The authors found 18 per cent of their cases to have bilateral obstruction to varying degrees, and emphasize evaluating the contralateral kidney, especially when nephrectomy is considered as a mode of therapy.

The indications for operation in children as in adults include pain, hydronephrosis and infection. Conservatism in treatment is justified, since the recuperative power of the young kidney is difficult to assess. The authors describe the type of pyeloplasty (ureteropyelostomy) for children which was easier to perform and led to excellent results.

With relief of symptoms as an endpoint, III satisfactory results were obtained out of 12I pyeloplasties. The relief of symptoms was not always commensurate with the urographic findings. The pyeloplasty was ineffective in 10 patients. Primary nephrectomy was performed in 4I patients and the obstruction was bilateral in 25 patients.—Daniel P. Link, M.D.

Bruezière, J., Guérior, J.-C., and Begué, P. La lithiase idiopathique du nourrisson: à propos de 40 observations. (Idiopathic lithiasis in infants: report of 40 cases.) J. Urol. et nephrol., July-Aug., 1974 80, 589-603. (Address: Masson et Cie S. A. Editeurs, 120, boulevard Saint-Germain, F 75280 Paris Cedex 06, France.)

The authors report on their observations during a 12 year period. Of 185 cases of renal calculi in children, 40 occurred in infants under 2 years of age.

There is no known cause for this type of lithiasis. There are no identifiable pathologic factors similar to those in adults as the cause of lithiasis.

Idiopathic renal lithiasis occurs predominantly in the male, approximately 3 times as often as in the female. More than half the cases occur during the first year of life.

The calculi are located in the renal pelvis and at the pelvo-ureteral junction, rarely in the ureter or bladder.

The calculi are soft, friable, and for the most part, are made of calcium phosphate. The calculi are bilateral in less than half of the cases.

Almost invariably, there is an associated B. Proteus infection, the organism which may be the responsible factor in the causation of these calculi.

The clinical signs and symptoms calling for investigation of the urinary tract are recurrent bouts of fever, suggesting urinary tract infection.

Hematuria was the initial symptom in 5 cases. In 2 cases, calculi were eliminated spontaneously.

Treatment consists of surgical removal of the calculi, pyelotomy being the preferred procedure.

Five tables and three projections of intravenous urograms on 6 patients accompany this report.— William H. Shehadi, M.D.

Ruffato, Cesare, and Giannoni, Ruggero. La lipomatosi pelvica: presentazione di un caso. (Pelvic lipomatosis: report of a case.) Radiol. med., July, 1974, 60, 571–580. (From: Ospedale Civile, via Ospedale, I-31033 Castelfranco Veneto, Treviso, Italy.)

The term pelvic lipomatosis was proposed in 1968 by Fogg and Smith to designate a benign and apparently nonprogressive pathologic process, characterized by massive proliferation of the adipose tissue in the perivesical-rectal region.

An analysis of the world literature based on 34 cases reported up to the present time, shows that this condition most often affects males. Only in 1 case (Malter et al., 1971) was the female sex affected. The ages varied between 9 and 80 years of age. The symptomatology most frequently is limited to urinary frequency, cysitis, dysuria, or constipation and abdominal pain.

Clinically, a mass can sometimes be felt deep in the hypogastric region, while the digital evaluation of the limits and characteristics of the prostate is made difficult by the altered topographic anatomy caused by the marked deposition of fat.

The roentgen findings demonstrated in standard roentgenograms of the abdomen, in excretory urography and cystography, and in a barium enema studies are: hyperlucency of the soft tissues of the pelvis; elevation and/or elongation of the bladder; medial displacement of the ileo-pelvic segments of the ureters; vertical elongation of the recto-sigmoid with narrowing of the lumen of the rectum while it still maintains its normal distensibility. Urethrography demonstrates a constant elongation of the posterior urethra, at times markedly angulated with deformity of the vesical neck.

In the case here reported, the authors performed also lymphangiography, which showed normal appearance of the lymph nodes with only slight lateralization and anterior displacement of the iliac lymphatic chain. A venography of the internal and external iliac veins showed a rather tortuous course of these veins, which also appeared reduced in caliber, with multiple smooth indentations anteriorly and laterally.

The patient, a man of 58 years of age, was operated on. The pelvic floor was "filled" by fat which surrounded the bladder, the prostate, the pelvic segment of the ureters and the recto-sigmoid. Most of this fatty mass was removed and histologic studies showed a normal adipose tissue without any evidence of inflammatory process.

Demonstrative illustrations accompany the article and the review of the literature is up-to-date. (In the same issue of *Radiol. med.* another case of pelvic lipomatosis, observed in a 63 year old man, is reported by Catalano, D. See also the recent report on this subject by Moss *et al.* in Am. J. Roentgenol., Rad. Therapy & Nuclear Med., 1972, 115, 411-419.)—A. F. Govoni, M.D.

### NERVOUS SYSTEM

ROVIRA, MOLIST M. Estudio angiográfico de la médula espinal. (Angiography of the spinal cord.) An. de med., Aug., 1974, 60, 689-701. (From: Servicio de Neurorradiología, Departamento Central de Radiología, Ciudad Sanitaria de la Seguridad Social, Barcelona, Spain.)

The main indication for spinal cord arteriography is for preoperative study of arteriovenous malformations. It would also be useful in preoperative assessment of spinal cord tumors, and herniated disks at the thoracolumbar junction. This is considered to be a relatively safe procedure.

For lesions in the thoracic or lumbar area the catheter is inserted into the aorta, percutaneously through the femoral artery, and then the intercostal and lumbar arteries (above the level of the lesion) are selectively catheterized and injected, bilaterally. A thorough study usually takes about 3 hours.

For lesions in the cervical area, selective catheterization of the vertebral arteries is done.

The examination is carried out under T.V.-fluoroscopic control; serial filming in frontal and lateral projections is done; and subtraction technique is used for optimal evaluation of the films.—Julian B. Alvarez, M.D.

### BLOOD AND LYMPH SYSTEM

GAGNON, JEAN H. Lymphography in filarial chyluria. J. Canad. A. Radiologists, Dec., 1974, 25, 319–323. (From: Department of Diagnostic Radiology, Royal Victoria Hospital and McGill University, Montreal, P. Q. H3A 1A1, Canada.)

Lymphangiography is useful in the investigation of chyluria in filariasis. The site and nature of an obstruction, and fistulous communications with the genitourinary tract can be determined.

Chyluria resulted from obstruction of the upper paraaortic lymphatics. There was retrograde flow of chyle from the gastrointestinal lymphatics into the lobar and intralobar renal lymphatics. Chyle escaped into the urinary tract when there was sufficient intralymphatic pressure to cause rupture of the lymphatic wall into renal tubules, or when permeability was lateral so that passage into the tubules occurred through open interendothelial junctions.

The affected lymphatic channels were dilated and tortuous with many short sacculations. Opaque contrast medium was detected in renal calycies and in the urinary bladder.

The thoracic duct was grossly dilated and showed areas of stenosis in 1. of the reported cases. The duct was normal in 4 other cases.

Lymph nodes occasionally were diffusely enlarged and had a coarse granular pattern that simulated malignant lymphomas. This has been attributed to an immunologic response to the parasite. Sparse and smaller lymph nodes due to cicatricial changes and fibrosis were late changes.

Chyluria subsided in some cases after lymphangiography. The iodinated contrast medium is suspected of having therapeutic properties.—Paul M. Dassel, M.D.

### SKELETAL SYSTEM

WILTSE, LEON L., WIDELL, ERIC H., JR., and JACKSON, DOUGLAS W. Fatigue fracture: the basic lesion in isthmic spondylolisthesis. J. Bone & Joint Surg., Jan., 1975, 57-A, 17-22. (Address: Leon L. Wiltse, M.D., 2840 Long Beach Boulevard, Suite 410, Long Beach, Calif. 90806.)

The authors state their belief that, with the exception of an occasional acute fracture of the pars interarticularis, all cases of isthmic spondylolysis or spondylolisthesis begin as a fatigue fracture. (Isthmus and pars interarticularis are used interchangeably.) The incidence of this defect rises precipitously between the ages of 5.5 and 6.5 years—a fact that has always been difficult to explain. It is also more frequent in the white population of the U.S. (5.8 per cent); whereas it occurs in only 1.9 per cent of Blacks.

The patients presented in this paper all had isthmic defects that developed in late childhood. Symptoms of persistent pain and muscle spasm were the causes for initial roentgenograms. All but I patient was engaged in vigorous athletics at the time of back pain. Despite adequate roentgenograms and multiple projections, a significant number of these lesions were overlooked by competent radiologists and orthopedists. If initial roentgenograms are considered negative and pain persists, follow-up roentgenograms should be taken at 3-6 week intervals until pain subsides.

Treatment consisted of knees-to-nipples cast, and body jacket, all affecting solid healing. In patients with isthmic spondylolisthesis at more than 2 levels, some but not all of the defects always healed. These patients were also found to have a familial history of this defect. Healing of the defect can result without treatment, but it usually remains pseudoarthritic. One patient's defect at L5 healed without immobilization, although she continued to do gymnastics!

The fine linear defect in the pars interarticularis differs from the other fatigue fractures in the following manner: (1) it appears earlier in life; (2) has hereditary predisposition; (3) fluffy periosteal callus formation is seldom seen; (4) the lesion seems to develop after minor trauma; (5) the defect tends to persist.

Clinically, fatigue fracture in all sites provokes symptoms before the roentgen defect can be seen.—

Lois Cowan Collins, M.D.



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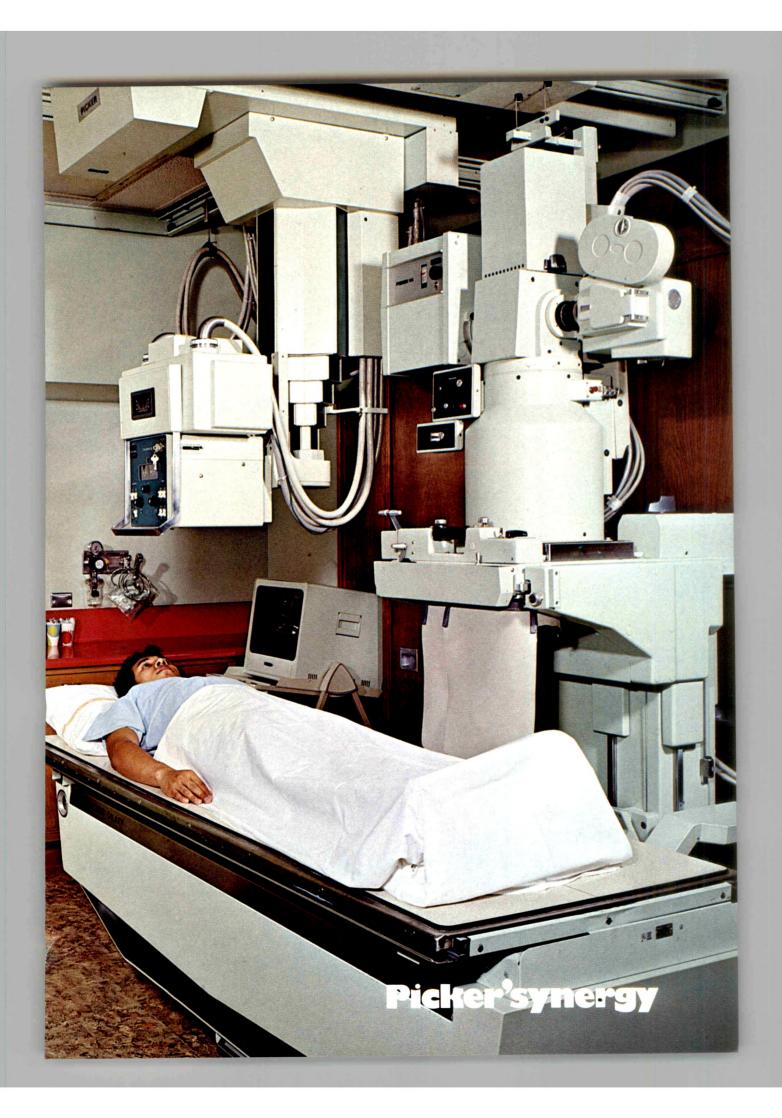
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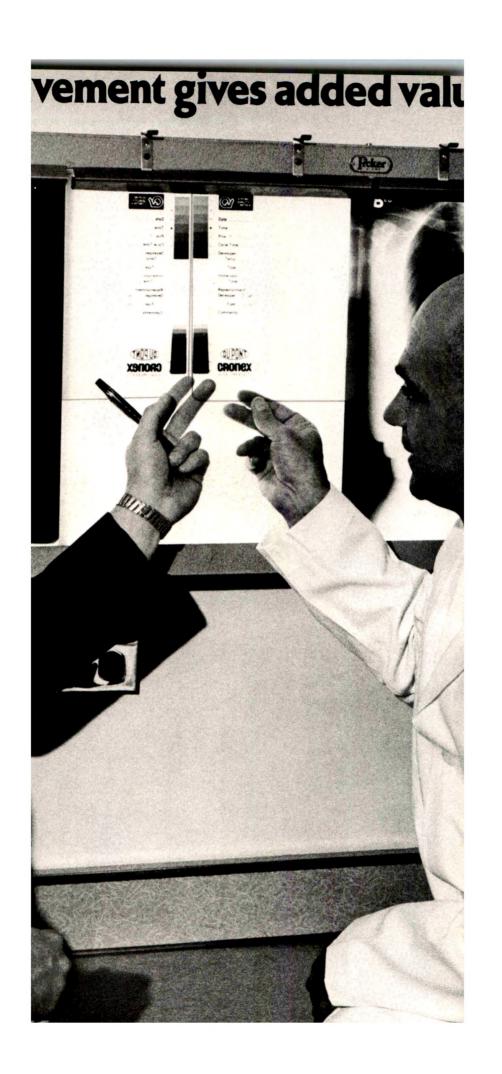
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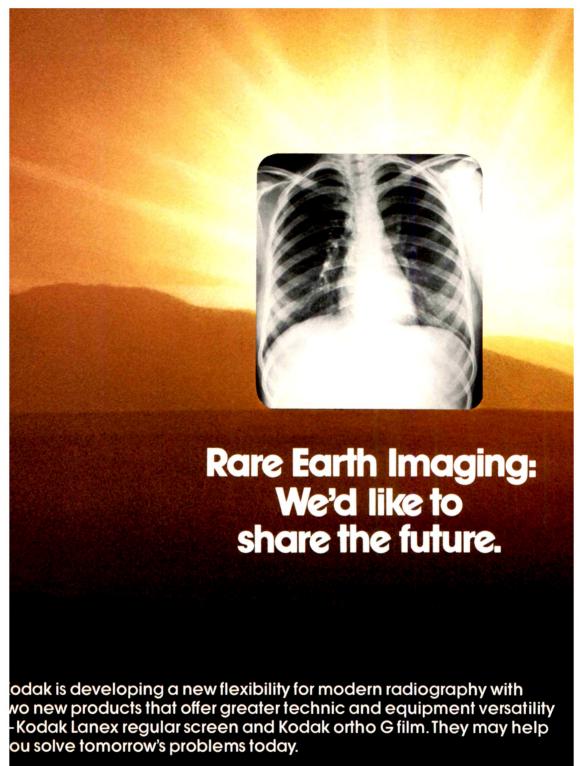
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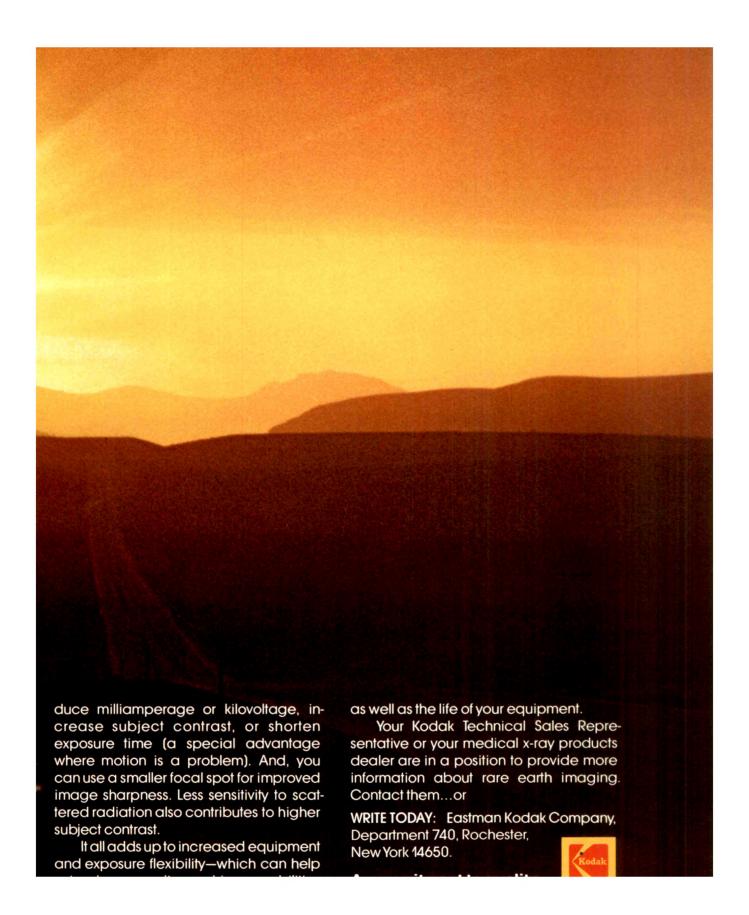


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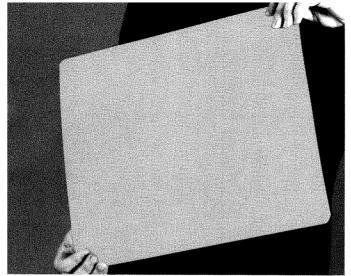
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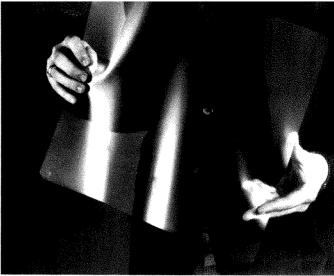
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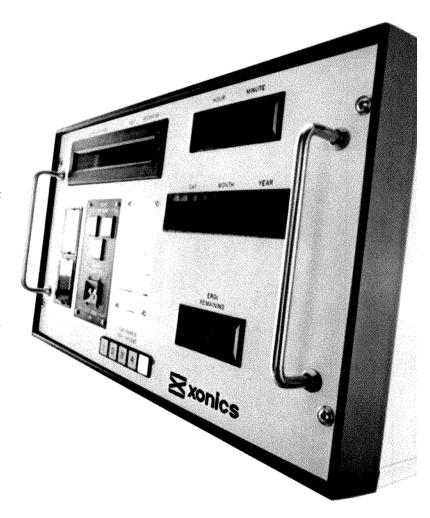
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INDICATIONS AND ALTERNATIVES IN X-RAY DIAGNOSIS: A Guide to the Effective Employment of Roentgenologic Studies in the Solution of Diagnostic Problems (2nd Ed.) by Melvyn H. Schreiber, Univ. of Texas Medical Branch, Galveston, Texas. This illustrated volume describes and depicts the various kinds of roentgenologic examinations available for the unravelling of diagnostic problems. It is divided into chapters based upon organ systems, with common abnormalities illustrated. Indications and contraindications are carefully defined. '74, 192 pp., 98 il., \$11.50, paper

MODERN THIN-SECTION TOMOGRAPHY edited by Arnold Berrett, New York Medical College, New York; Sam Brunner, Gentofte Hospital, Copenhagen, Denmark; and Galdino E. Valvassori, Univ., of Illinois, Chicago. Foreword by Solve Welin. (21 Contributors) Contains chapters on the history of tomography and the physical principles involved, as well as a description of many of the machines employed. Numerous sections dealing with tomographic anatomy and technical factors follow with a description of the clinical applications of the method in various parts of the body. A significant portion is devoted to clinical problems encountered in the region of the head and neck. '73, 352 pp. (7 x 10), 496 il., 17 tables, \$26.50

A STUDY GUIDE FOR NUCLEAR MEDICINE: A Modern Up-to-Date Presentation compiled and edited by Fuad Ashkar, August Miale, Jr., and William Smoak, all of the Univ. of Miami, Miami, Florida. (22 Contributors) Covered in this text are such topics as interaction of gamma rays with matter, control of radiation exposure to man, electrolytes and body composition, essentials of rectilinear scanning, cardiovascular imaging and treatment of thyroid disease with radioiodine. This book is a necessity for persons studying for the examination of the American Board of Nuclear Medicine. '75, 488 pp., 312 il., 44 tables, cloth-\$22.75, paper-\$17.50

**ELEMENTS OF RADIATION PROTECTION by** Ronald V. Scheele and Jack Wakley, both of the Univ. of Virginia School of Medicine, Charlottesville. Virginia. Information in this textbook includes atomic structure, ionizing radiation, interaction of radiation with matter, sources of radiation exposure, biological manifestation of radiation exposure, permissible dose limits, principles of radiation protection and monitoring devices. Several chapters of the book deal with federal performance standards and Atomic Energy Commission regulations. The material content and mode of presentation are clear and nonmathematical for those students who have little background in physics and mathematics. '75, 112 pp., 15 il., 10 tables, \$7.95, paper

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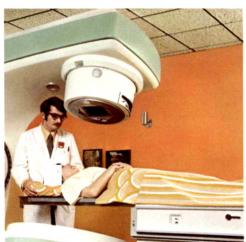
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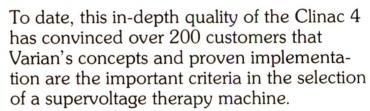
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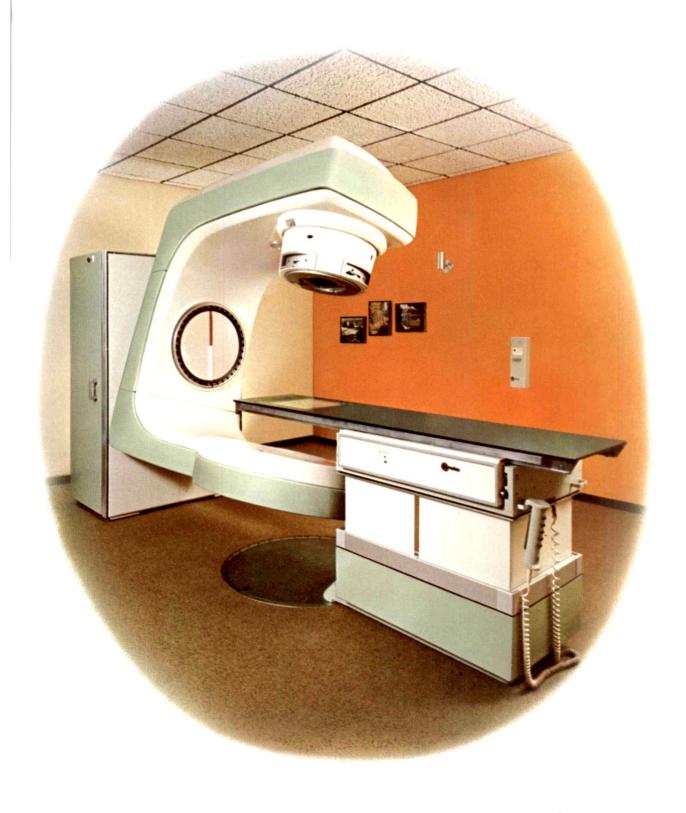
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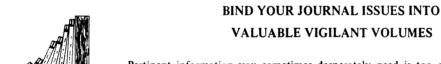
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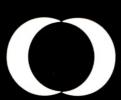
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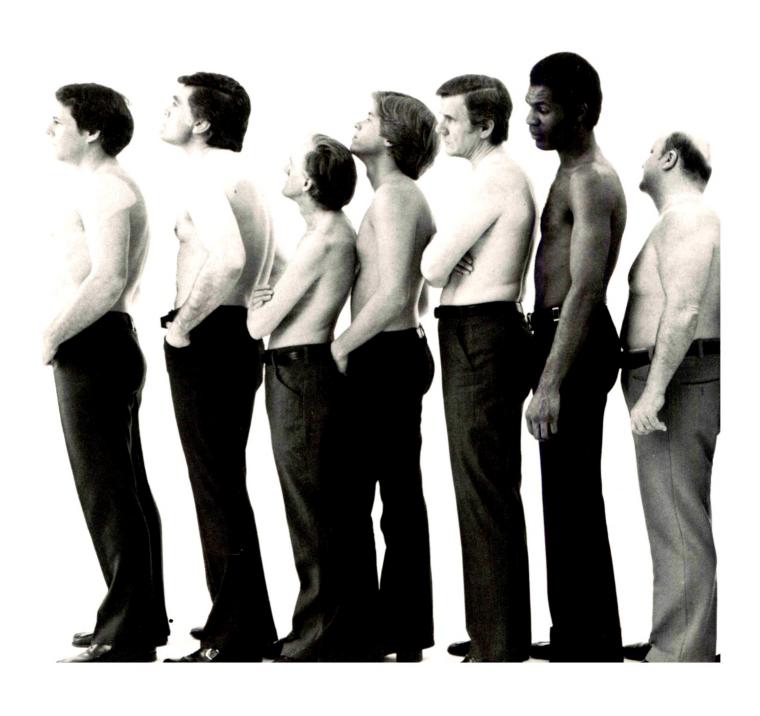
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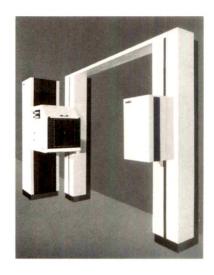
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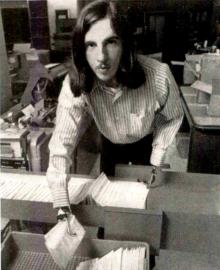




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Mildred Hudson (bottom center), a coding and terminations clerk for Standard Security Life Insurance.

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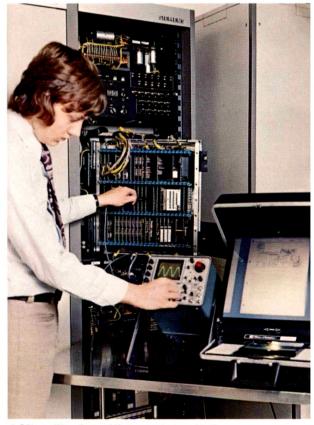
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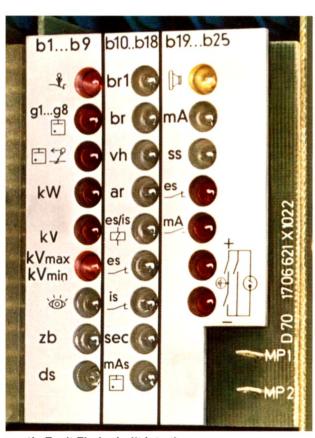
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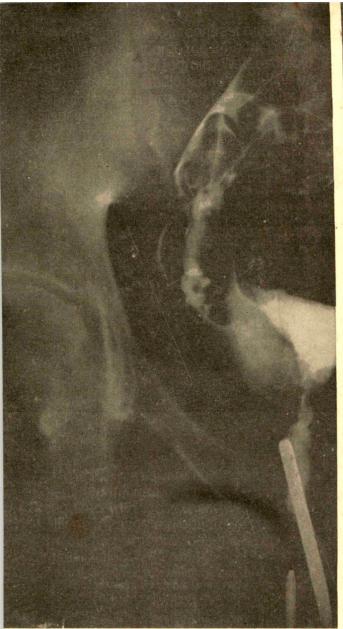


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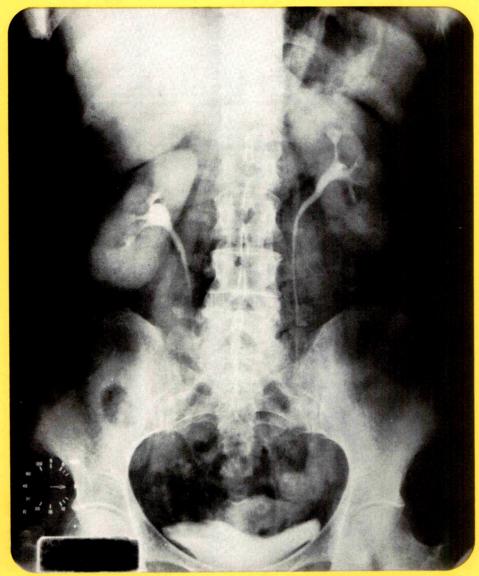
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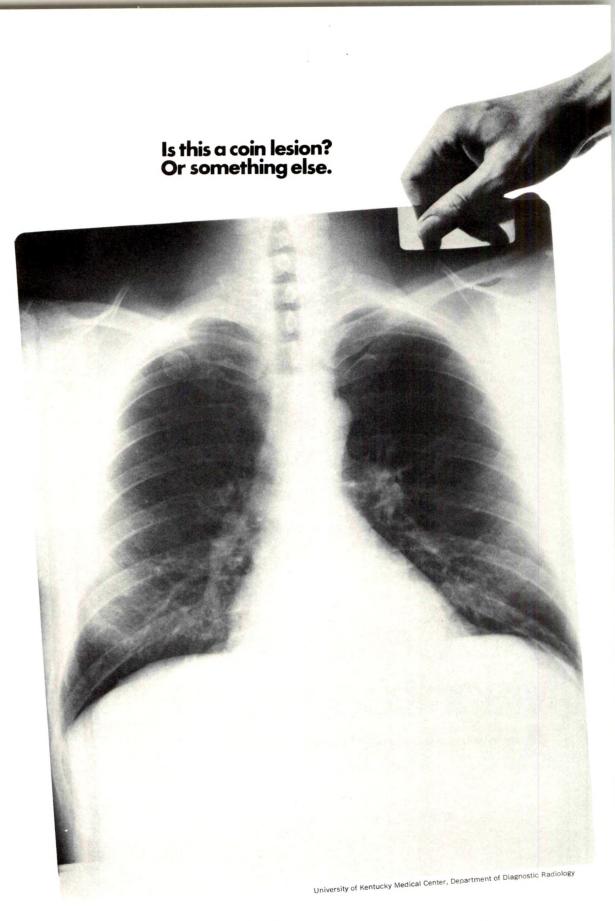
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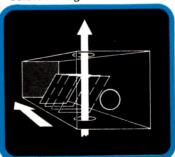
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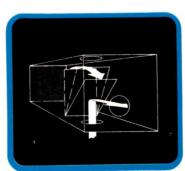
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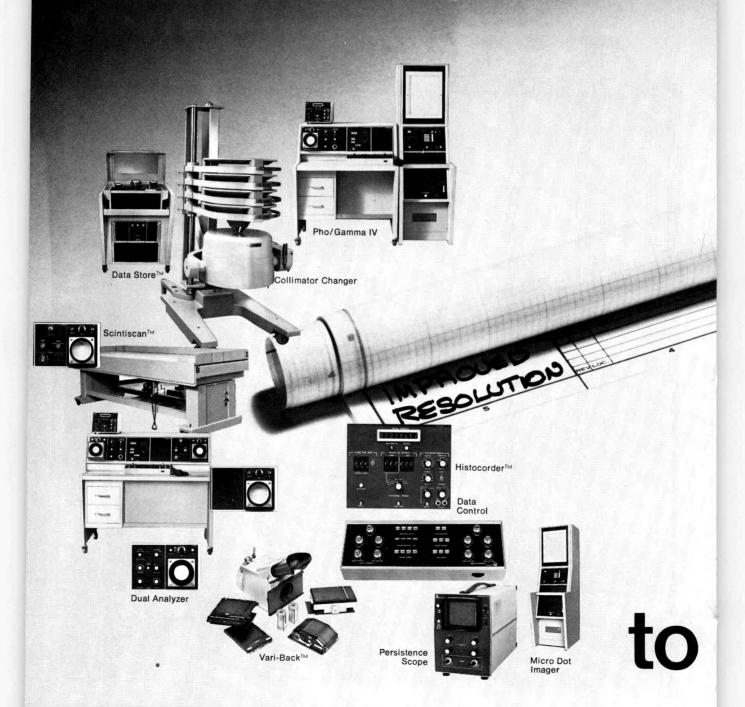
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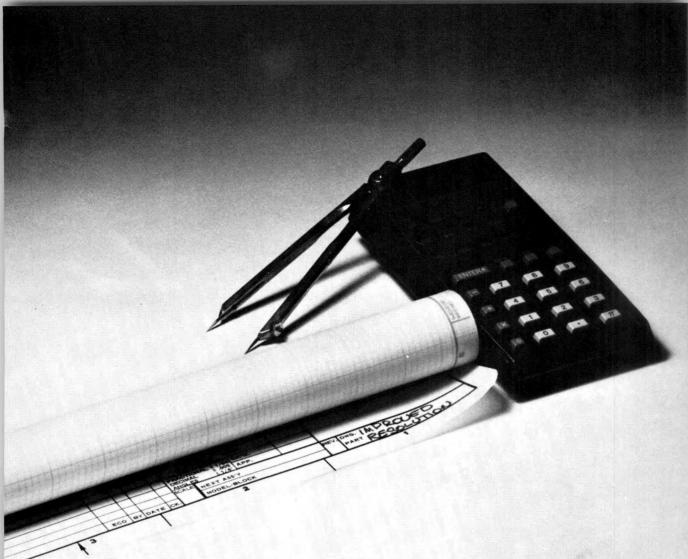




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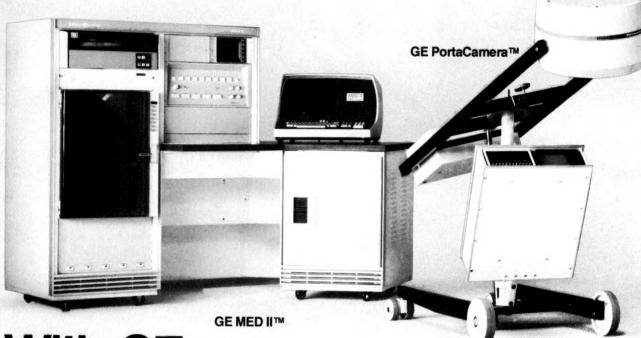
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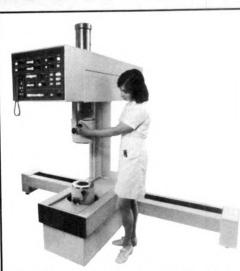
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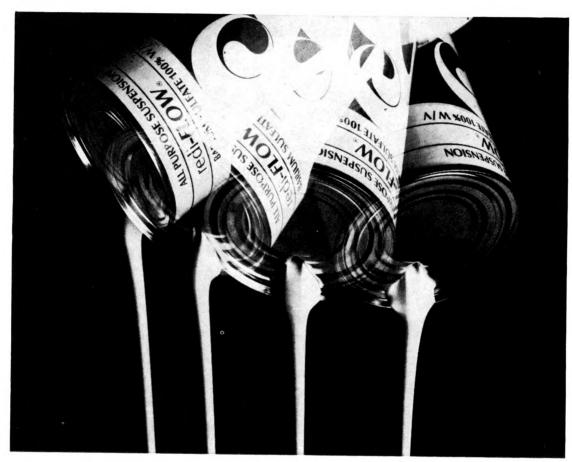
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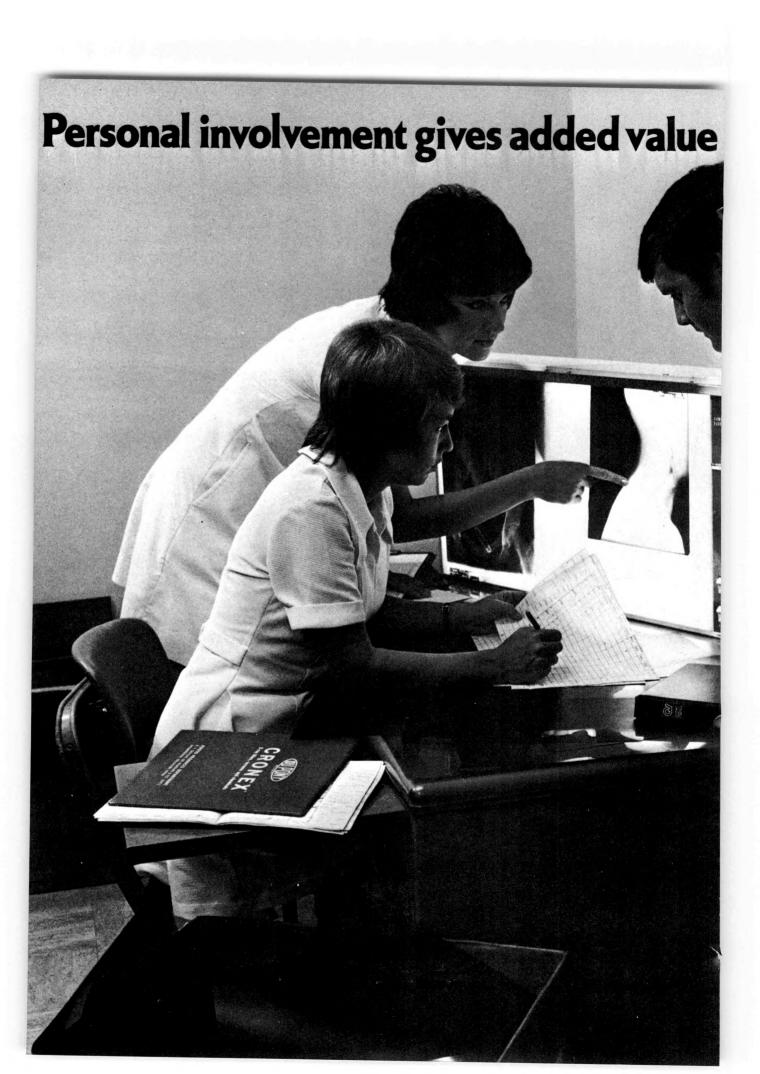
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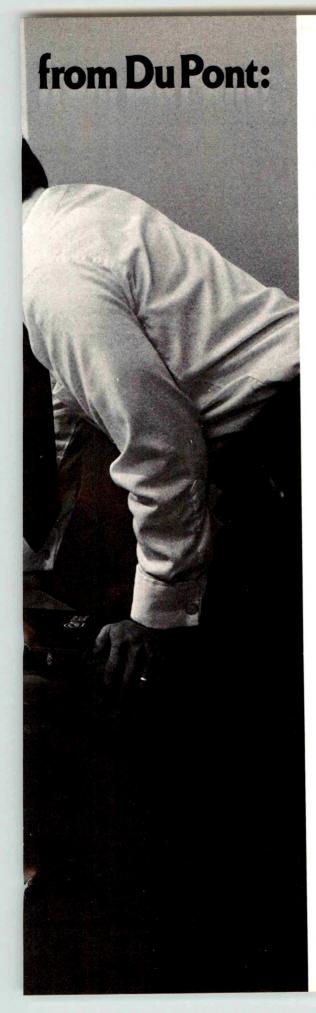
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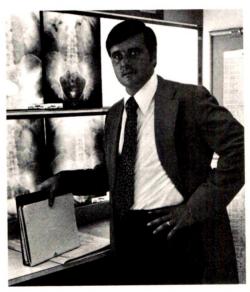
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ELEMENTS OF RADIATION PROTECTION by Ronald V. Scheele, and Jack Wakley, both of the Univ. of Virginia School of Medicine, Charlottesville, Virginia. Information in this textbook includes atomic structure, ionizing radiation, interaction of radiation with matter, sources of radiation exposure, biological manifestation of radiation exposure, permissible dose limits, principles of radiation protection and monitoring devices. Several chapters of the book deal with federal performance standards and Atomic Energy Commission regulations. '75, 112 pp., 15 il., 10 tables, \$7.95, paper

A STUDY GUIDE IN NUCLEAR MEDICINE: A Modern Up-to-Date Presentation compiled and edited by Fuad Ashkar, August Miale, Jr., and William Smoak, all of the Univ. of Miami, Miami, Florida. (22 Contributors) Covered in this text are such topics as interaction of gamma rays with matter, control of radiation exposure to man, basic mathematics of nuclear medicine, electrolytes and body composition, essentials of rectilinear scanning, cardiovascular imaging and treatment of thyroid disease with radioiodine. This book is a necessity for persons studying for the examination of the American Board of Nuclear Medicine. '75, 488 pp., 312 il., 44 tables, cloth-\$22.75, paper-\$17.50

DIAGNOSTIC AND THERAPEUTIC AIDS IN UROLOGY by Henry Bodner, Loma Linda Univ., Los Angeles, California. In Collaboration with John S. Arconti, Jr., Allan H. Howard and Robert O. Pearman. Illustrated by John S. Arconti, Jr. The contributions of some 150 urologists in private practice and faculty members of university medical centers are interpreted by the authors. Tailored for diagnosis and application at bedside, in the office and operating room, this book outlines valuable "tricks of the trade" in urology which do not appear in standard textbooks. All physicians in related areas will find this book a valuable innovation. '74, 376 pp. (6 3/4 x 9 3/4), 82 il., 5 tables, \$24.75

RADIONUCLIDE SCANNING IN CYANOTIC HEART DISEASE by Gary F. Gates, UCLA, Los Angeles, California. This monograph describes a new, unique application of nuclear medicine in the clinical management of children with cyanotic congenital heart disease. Following intravenous administration of 99mTc-macroaggregated albumin and total body scanning with a scintillation camera, accurate calculation of right-to-left shunting can be achieved without cardiac catheterization. Furthermore, the distribution of pulmonary arterial blood flow between the lungs can be determined. The procedure is described fully; steps used in performing the examination are outlined and possible pitfalls and sources of error are discussed. '74, 114 pp., 88 il., 5 tables, \$15.00

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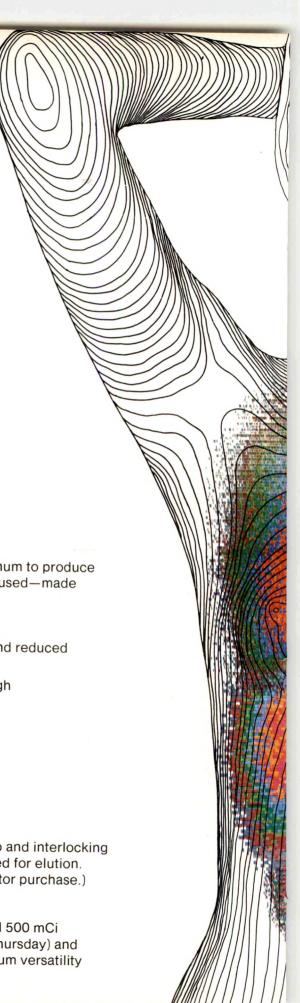
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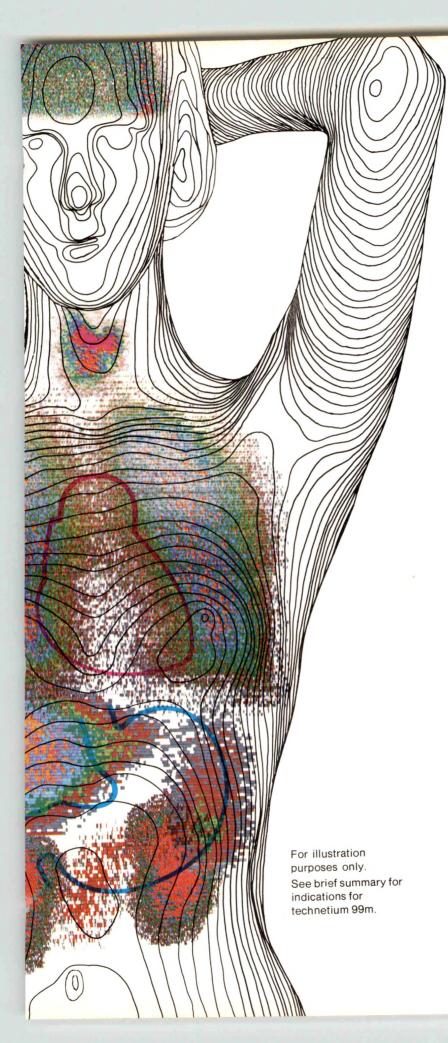
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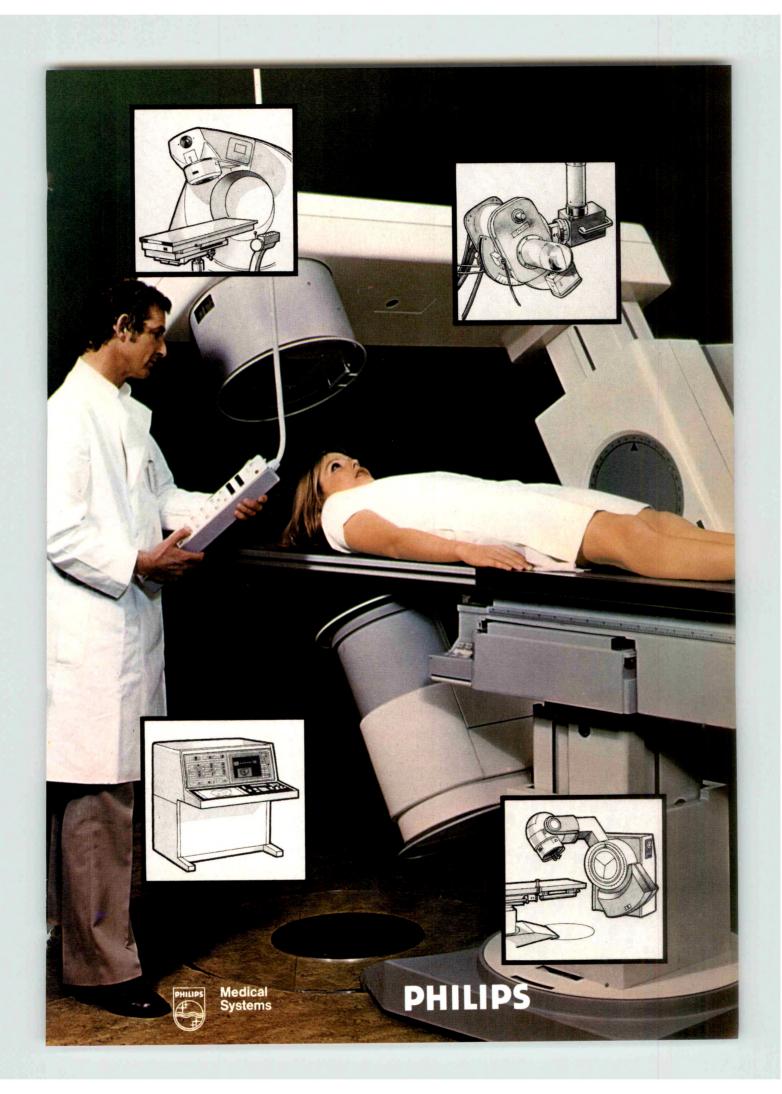
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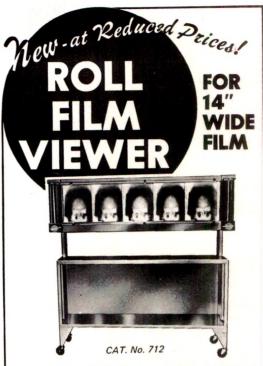


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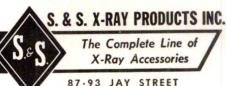
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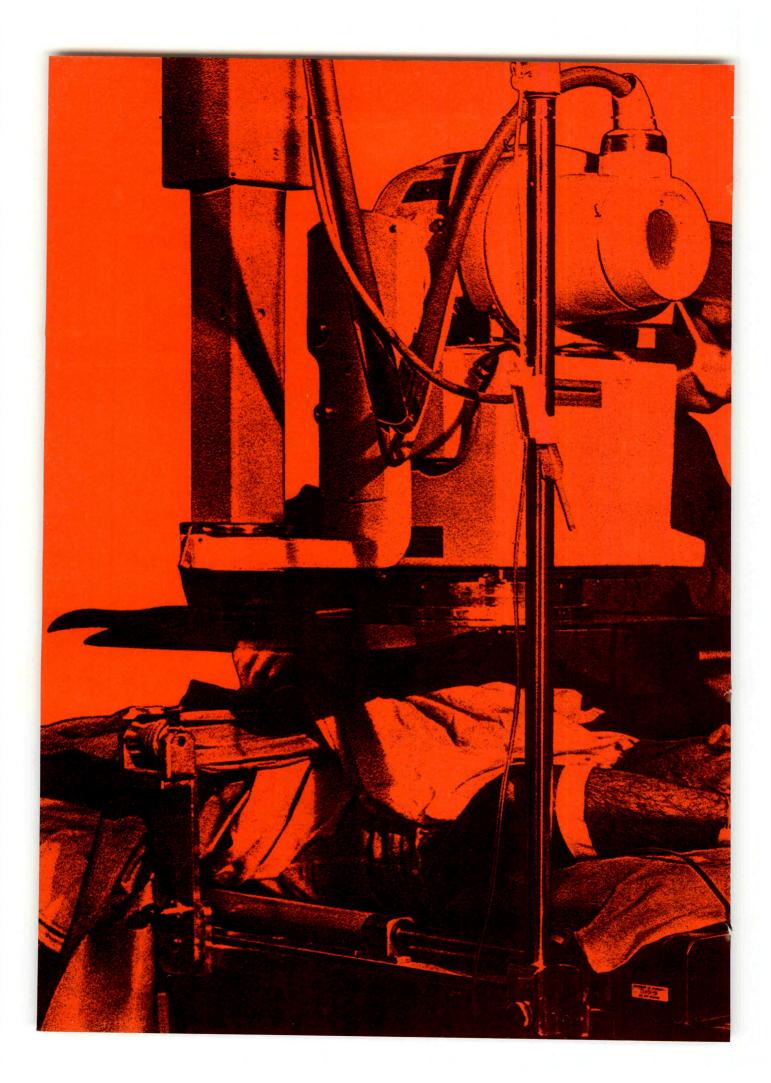
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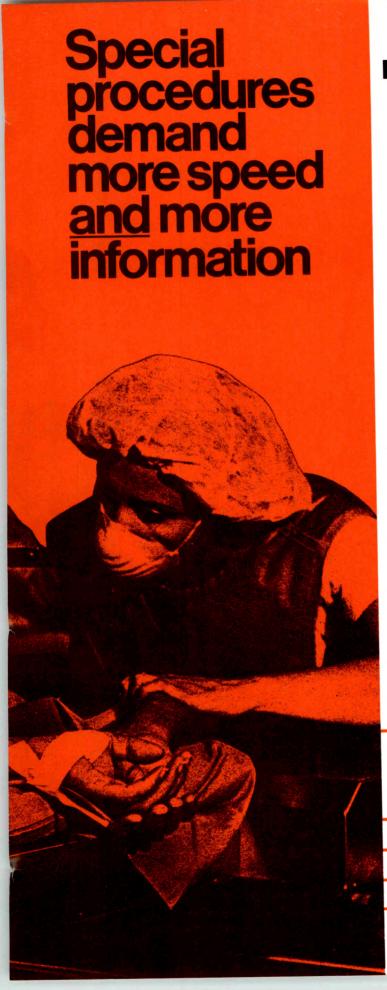
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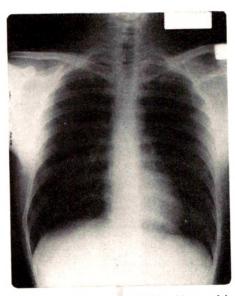
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## THE AMERICAN JOURNAL OF ROENTGENOLOGY RADIUM THERAPY AND NUCLEAR MEDICINE

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### XEROTOMOGRAPHY OF THE TRACHEOBRONCHIAL TREE\*

By THOMAS S. HARLE, M.D.,† JAMES M. HEVEZI, Ph.D.,‡ LEE F. ROGERS, M.D.,§ JOHN E. MARTIN, M.D.,|| and BAO-SHAN JING, M.D.|| HOUSTON, TEXAS

APPLICATION of the xerographic process to tomography is a valuable aid in the evaluation of the tracheobronchial tree. Our interest in this combination of modalities results from the clear demonstration of stenosis of the trachea on a single oblique tomographic view using xerography (Fig. 1). Prior conventional views of the chest and linear film tomograms of the trachea in this patient failed to reveal the suspected narrowing. This experience prompted utilization of the xerotomographic technique in selected patients with disorders of the tracheobronchial tree.

### MATERIAL

Qualitatively, xerotomographic images appear superior to those on film tomograms (Fig. 2, A and B). The wide latitude of xerography permits visualization on a single image of the trachea and its bifurcation within the dense mediastinum, as well as the main bronchi and segmental subdivi-

sions in the more radiolucent hilar regions (Fig. 3, A and B). This obviates the need for multiple exposures at varying techniques or specially designed and engineered filters as with film tomography to visualize these structures. Also, oblique projections can be obtained readily without additional techniques or filters. The visual enhancement of interfaces between different densities (edge enhancement) is an inherent property of xerography and of great value in detection of masses.<sup>1,5,6</sup>

The quality of the xerotomograms in several cases was such that anticipated special studies such as bronchoscopy and bronchography were not performed (Fig. 4, A and B).

In an attempt to substantiate our impression that xerotomography produces better images than film tomography of the trachea and bronchi, we investigated and compared the physical aspects of both modalities.

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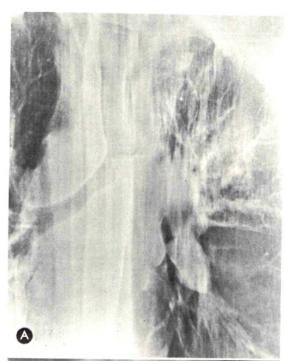
<sup>†</sup> Professor of Radiology. ‡ Assistant Professor of Radiology. § Associate Professor of Radiology. ∥ Clinical Associate in Radiology.



Fig. 1. A 33 year old male treated 2 months previously for severe chest injury following an automobile accident. Tracheal stenosis developed at the site of endotracheal cuff pressure.

### PHYSICAL ASPECTS

Tomography may be considered as a recording of 2 types of information. Object details, which lie in the plane about which the x-ray tube-recording system move (fulcrum plane), are imaged as if only that plane, albeit of finite thickness, was radiographed. Superimposed on this are structures attributable to object details above and below the fulcrum plane which, owing to the particular motion during recording, are imaged as blurred structures. This blurring increases the farther the object details are from the fulcrum. The undesirable blurred details are low spatial frequency information which reduces contrast in the fulcrum plane. Previously, attempts have been made to remove the motion blur by image processing after the tomograms



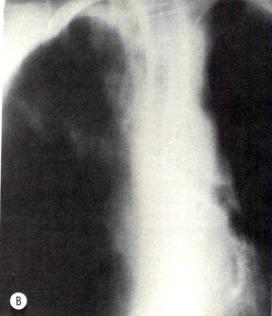


Fig. 2. A 37 year old male with proved diagnosis of carcinoma of the right lung.

(A) Xerotomogram at midline of chest demonstrates tumor extending from the right main bronchus and hilar region into the carinal area and lower trachea. (Xerotomographic images are reversed as to right and left compared to roentgenograms.) (B) Linear film tomogram at the same level does not demonstrate this mass as clearly.

have been produced.2 These methods involve a two-step process and have not come into general use. A recording system which selectively reduces low spatial frequency information and enhances the higher frequencies is desirable. These features are present inherently in the xerographic process. Figure 5 illustrates in a qualitative fashion the modulation transfer function for a screen-film system (a), and xeroradiography (b).3 The curve for xerographic recording indicates the selective attenuation of low spatial frequencies in the image which is a desired feature for tomography. Resolution for xeroradiography lies between that of industrial film and film-screen systems. Subjectively, this is adequate for tomography of the tracheobronchial tree. Other tomographic techniques may require greater resolution, but this must be determined for each area.

Thickness of cut for film tomography and xerotomography at a fixed tomographic angle (40°) was determined using a lead bar line test pattern. The fulcrum was moved in millimeter increments above and below the level of the test pattern and the resulting images analyzed for amount of blurring at each frequency. The results are shown in Figure 6, where the last discernible group of bars is plotted as a function of displacement from the fulcrum. Thickness of cut cannot be defined precisely but at an arbitrary ordinate value, the full width of the curve indicates thickness of cut. At all frequencies, the xerographic thickness of cut exceeds the film-screen value.

Xerography is less sensitive to x-rays than film-screen combinations. Thus more radiation must be used to produce satisfactory images. Patient exposures were measured with calibrated thermoluminescent dosimeters placed on the surface of the patient in the middle of the field. For the

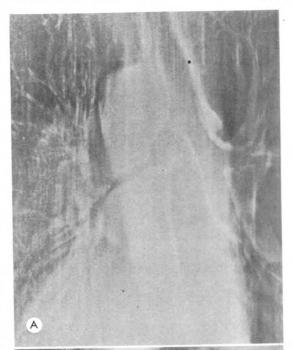




Fig. 3. (A) A 54 year old male with carcinoma of the left main bronchus. Note the narrowing of the left main bronchus. The segmental bronchi are clearly visualized on the right as well as the main bronchi. (B) A 63 year old woman with repeated episodes of right middle lobe pneumonia. Oblique xerotomogram demonstrated not only the main bronchus, but also the lobar divisions. The right middle lobe bronchus is well visualized with no evidence of narrowing.

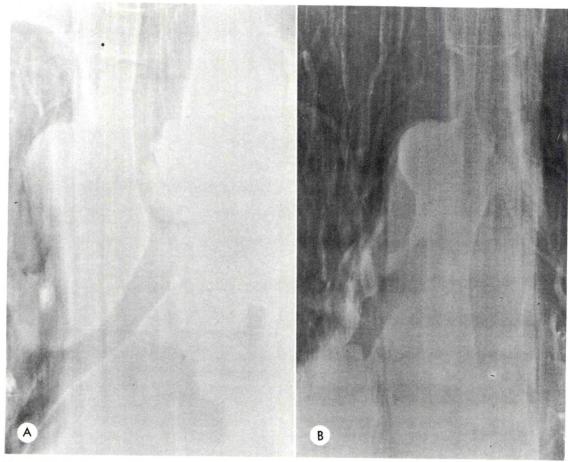


Fig. 4. (A) A 65 year old male with history of right pneumonectomy 6 years previously. He developed shortness of breath. The xerotomogram demonstrates a mass almost occluding the trachea. Bronchoscopy which had been scheduled for the next day was cancelled and radiation therapy instituted. (B) A 73 year old male with left lower lobe consolidation. Xerotomography demonstrates mass occluding the left lower lobe bronchus. Bronchography had been scheduled but was cancelled due to demonstration of this occlusion. Biopsy at bronchoscopy revealed squamous cell carcinoma.

average film tomogram technique employed (62 kVp., 25 mAs.), the exposure measured 470 mr. In contrast, the average xerotomographic technique (120 kVp., 200 mAs.) resulted in an exposure of 7.5 r. On a per exposure basis, the exposure for xerotomography is approximately 15 times that of the film-screen system employed at this institution. However, due to the wide radiographic latitude of xerography, a single xerotomogram may be sufficient to arrive at a diagnosis, whereas many film tomograms might be required. While we feel that xerotomographic images are preferable to those of film tomography, the pa-

tient exposure is too high to justify the use of xerotomography in this area routinely.

The quality and potential of this technique warrant attempts to reduce exposure levels. As a step in this direction, we have increased the sensitivity of the xerographic process by installation of a high atomic number gas within the xerographic cassette. This technique nearly doubles the sensitivity, thereby reducing the patient exposure by one-half with only slight loss of resolution.

### SUMMARY

The inherent features in xerography of

wide latitude, edge enhancement, and reduction of the off fulcrum plane blur make it a desirable recording modality to use in conjunction with tomography.

Xerotomographic images appear superior to those of film tomograms.

The principal obstacle to routine use of xerotomography in this area is the high patient exposure. Attempts to increase the sensitivity of the xerographic system thereby reducing patient exposure, are being investigated.

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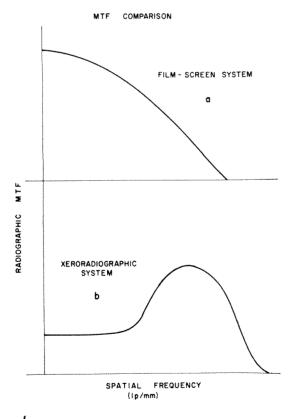


Fig. 5. Modulation transfer function (MTF) comparison between (a) screen-film and (b) xerographic recording media. Note the selective attenuation of low spatial frequency information afforded by the xerographic recording process.

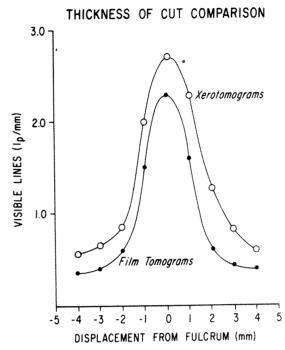


Fig. 6. Thickness of cut comparison between xerotomograms and film tomograms. Tomograms were made using 40° linear cuts of a lead bar pattern; data are plotted as the last visible line pattern group versus the displacement of the lead pattern from the fulcrum plane.

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### SOFT TISSUE CALCIFICATIONS IN SYSTEMIC LUPUS ERYTHEMATOSUS\*

By JOEL A. BUDIN, M.D., and FRIEDA FELDMAN, M.D.†
NEW YORK, NEW YORK

SOFT tissue calcification, a well known roentgen manifestation of connective tissue disorders, is commonly associated with scleroderma and dermatomyositis. Its occurrence in systemic lupus erythematosus (SLE), however, has been rarely appreciated and little emphasized. To the best of our knowledge only 8 cases have previously been documented in detail.<sup>3,5-10</sup>

It is the purpose of this paper to present 9 additional cases noted among 130 cases of SLE seen at the Columbia-Presbyterian Medical Center and to emphasize that such soft tissue calcification may be present in relation to the skin and deeper soft tissues, as well as in relation to the peripheral vasculature.

The salient clinical and laboratory features of our 9 patients are summarized in Table 1. The details of 3 representative cases follow.

### CLINICAL FINDINGS

The ages of our I male and 8 female patients ranged from 19 to 60 years. Subcutaneous calcification of the lower extremities was the most common manifestation, occurring in 7 of our cases. Calcifications were bilateral and diffusely distributed in 3 of these patients, while 4 had unilateral localized calcific deposits. One of these cases demonstrated diffuse calcifications of the upper as well as the lower extremities. Two patients showed premature vascular calcification involving the femoral and popliteal arteries. Periarticular calcifications of the hand were seen in I case.

Three patients had calcific nodules at sites of previous or current cutaneous inflammation or ulceration. The remaining 6

patients had no associated cutaneous findings in the extremities.

### REPORT OF CASES

CASE I. This 19 year old girl was first seen in 1965 with recurrent fever, arthralgias, a malar rash, and leukopenia. She had a positive LE cell preparation, a high anti-DNA titer, and a low serum complement. She was treated with prednisone and hydroxychloroquine. In 1968 she developed severe bilateral retinal vasculitis which responded well to massive doses of steroids. Because of a persistent rash on her face and arms, albuminuria, and steroid induced osteoporosis, azathioprine was begun. In 1969, renal biopsy revealed membranous and proliferative glomerulonephritis. In 1972, painless bilateral lower extremity nodules with surrounding areas of depigmentation were followed by the development of indolent ulcers and draining sinuses. Roentgenograms of her lower extremities in March 1973 revealed diffuse linear and nodular calcifications in the subcutaneous and deep tissues of both thighs and legs (Fig. 1, A and B) as well as extensive calcification of the femoral and popliteal arteries (Fig. 1, C and D). A similar pattern of calcification was subsequently demonstrated in both upper extremities, but without evidence of vascular calcifications (Fig. 1, E and F).

Case II. This 60 year old woman was first diagnosed as having SLE in 1958 with the advent of arthralgias, fever, and easy bruisability. Laboratory evaluation revealed leukopenia, thrombocytopenia, a positive LE cell test, positive direct Coomb's test, elevated serum gamma globulin, and a negative latex fixation. In 1961 she developed bilateral pleural effusions. Despite steroid therapy, progressive deforming arthritis of her hands and feet ensued, with metacarpal-phalangeal joint subluxations and flexion contractures. Multiple

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<sup>\*</sup> Presented at the Seventy-fifth Annual Meeting of the American Roentgen Ray Society, San Francisco, California, September 24-27,

TABLE I
SUMMARY OF DATA IN 9 CASES

Case	Age,	Sex	Location of Calcification	Clinical Features	Laboratory Data
I. (G.T.)	19	F	Diffuse: subcutaneous and deep Both thighs, legs, arms and forearms Femoral and popliteal arteries	Fever, arthralgia, nephritis, rash, retinal vasculitis, leg ulcers	+LE prep, +antinuclear antibody, V serum complement, leukopenia. Renal biopsy: membranous and proliferative glomerulonephritis
II. (J.H.)	60	F	Diffuse: subcutaneous and deep Both lower legs and thighs	Fever, arthritis, pleural effusions, multiple infections, leg ulcers	+LE prep, +direct Coomb's,  serum gamma globulin,  -latex fixation
III. (V.G.)	23	F	Periarticular tissues of hand	Malar rash, arthralgia, nephritis, aseptic necrosis femoral heads	"Suspicious" LE prep x2,  sedimentation rate,  latex fixation
IV. (F.W.)	52	F	Diffuse: deep Both lower legs	Rash, alopecia, Raynaud's syndrome, venous insufficiency of lower extremities	+LE prep, V serum complement, Farr antibody 53 per cent, +latex fixation. Skin biopsy: + antibody to basement membrane and nuclei
V. (M.K.	) 22	F	Localized: superficial (R) lower leg	Numbness of hands and fingers, arthralgia, nephritis, pyoderma, recurrent thrombophlebitis	+LE prep, +LE immuno-fluorescence, +STS, +latex fixation
VI. (E.J.)	40	F	Localized: deep (L) thigh	Weakness, arthralgia, fever, lymphadenopathy, nephritis	+LE prep, + antinuclear antibody,  y serum complement. Renal biopsy: proliferative glomerulonephritis
VII. (A.F.)	20	F	Localized: deep (R) thigh	Athralgia, rash, proteinuria	+Anti-DNA, ▼ serum complement
VIII. (M.C.	) 34	M	Femoral arteries-bilateral	Rash, purpura, nephritis, aseptic necrosis femoral heads	+Antinuclear antibody +direct Coomb's +VDRL thrombocytopenia
IX. (P.B.)	23	F	(L) popliteal fossa	Arthralgia, rash, nephritis, aseptic necrosis (L) distal femur	+LE prep, +antinuclear antibody +VDRL. Renal biopsy: lobular glomerulonephritis

episodes of infection, including a perforated diverticular abscess, osteomyelitis of the right distal radius and ulna, and abscesses of the abdominal wall, buttocks, arms and feet, necessitated almost continuous hospitalization between 1961 and 1963. In 1965 and 1966 she was treated for recurrent leg ulcers. Roentgenograms of her lower extremities in 1972 (Fig. 2, A-C) revealed diffuse nodular subcutaneous calcifications involving both distal thighs and lower legs.

Case III. A 23 year old woman was first seen in 1959, at age 17, for a malar rash which was aggravated by sunlight. In 1960, she developed malaise, progressive ankle edema, and arthralgias, and was found to have nephrotic syndrome. She responded well to dexamethasone. In 1963 and 1964, bilateral aseptic necrosis of the femoral heads necessitated their replace-

ment with Austin-Moore prostheses. In 1965, investigation of the persistent albuminuria and edema revealed an erythrocyte sedimentation rate of 114, two "suspicious" LE cell tests, and a negative latex fixation. A roentgenogram of the left hand taken for arthralgias and swelling showed calcifications in the periarticular soft tissues of the interphalangeal and metacarpal-phalangeal joints (Fig. 3). Steroid dose adjustment afforded symptomatic relief.

### DISCUSSION

Several patterns of calcification were noted in this series. Three patients (Cases I, II, and IV) exhibited diffuse, linear, streaky, or nodular calcific conglomerates or a combination of these in the subcutaneous and deeper tissues of the lower extremities. Case I had the most extensive involve-

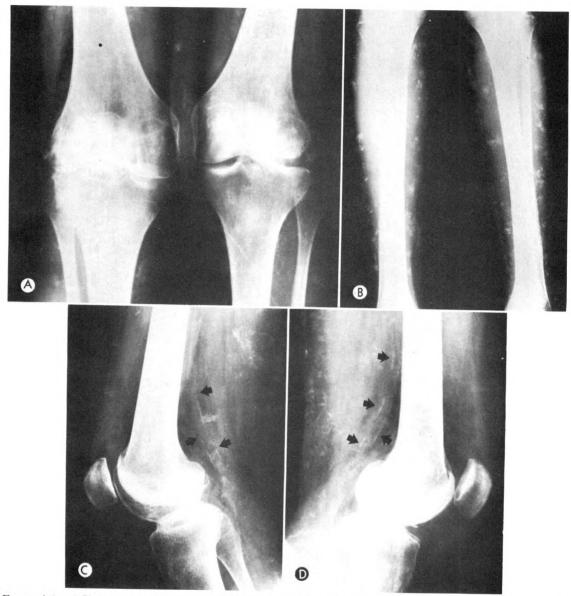


Fig. 1. (A and B) Anteroposterior views of the thighs and lower legs show multiple discrete nodular areas of calcification in the superficial and deeper soft tissues. (C and D) Lateral views of both knees show additional plaques of calcification, as well as heavily calcified femoral and popliteal arteries (arrows) in this 19 year old girl.

ment, with calcifications in the upper extremities as well. A similar pattern was noted in 2 previously reported cases. 9,10 Only I of our 3 patients (Case IV) had clinical evidence of venous insufficiency, but in addition, this patient had a severe diffuse cutaneous eruption with demonstrable antibodies to nuclei and basement membrane on skin biopsy. Cases I and II

had no evidence of venous insufficiency to account for the roentgenographic findings. Both, however, had a history of recurrent indolent leg ulcers, a not uncommon cutaneous manifestation of SLE, occurring in 29 of 520 cases reported by Dubois.<sup>3</sup> In certain instances, leg ulcers have preceded by months or years the typical picture of SLE.<sup>1</sup> The etiology of these ulcers remains con-

jectural. Although a vasculitis has often been hypothesized, histopathologic support for this explanation is lacking, and indeed, clinical response to steroids has been inconsistent. Of interest in both Cases I and II is the occurrence of soft tissue calcification in those areas involved with recurrent ulcerations. This association suggests that the calcification may have been precipitated by chronic inflammation and tissue necrosis.

Case v had a palpable plaque-like calcific deposit along the anterior aspect of the lower leg without associated eruption or ulceration. This type of calcification was observed by Kabir and Malkinson.5 In 1 of their patients, calcinosis cutis developed 7 years prior to the onset of SLE, a situation reminiscent of the prior appearance and subsequent association of calcinosis universalis with dermatomyositis in childhood. After the onset of SLE in this case, however, many of the newly developing calcific nodules arose at sites of cutaneous inflammation, again suggesting local predisposing factors. In the second case of Kabir and Malkinson, the calcific nodules corresponded to areas with skin lesions of discoid lupus.

Calcifications of the arteries of the lower extremities were observed in Cases I and VIII, ages I9 and 34 respectively. While in Case I, diffuse subcutaneous calcifications were also present, arterial calcification was the only manifestation in Case VIII. Neither of these patients was diabetic, and both had repeatedly normal serum calcium and phosphate determinations.

Since Baehr et al.'s classic paper,<sup>2</sup> SLE has been recognized as a diffuse disease in which inflammatory and degenerative changes may involve small vessels. Raynaud's phenomenon has been frequently stressed as one of the manifestations which may precede the onset of SLE by many years. It is not well realized, however, that the same may also be true of other vascular complications. Only isolated reports of peripheral arterial occlusion, gangrene, thrombophlebitis, livedo reticularis

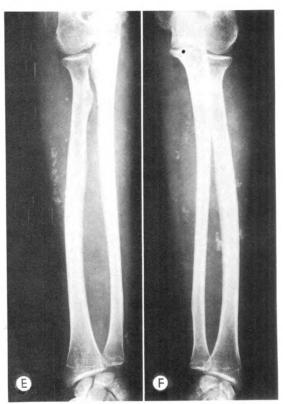


Fig. 1. (E and F) Anteroposterior views of both forearms demonstrate a similar pattern of calcifications.

and erythermalgia have appeared, while premature calcification of major peripheral vessels, particularly as detected on roentgenograms, has received even less attention.

Alarcon-Segovia and Osmundson¹ in their report of 11 cases of SLE seen at the Mayo Clinic, indicate that peripheral vascular manifestations were the initial clinical presentation in 7, preceding the onset of other better recognized signs and symptoms by many years. They also noted that when vascular manifestations occurred, they tended to be multiple and recurrent, i.e., in 7 of 11 patients. Unfortunately, roentgen documentation of vascular calcification was not alluded to.

Periarticular calcifications in the hand as demonstrated in Case III (Fig. 3) were observed in 2 previously reported patients.<sup>7,8</sup>

In the remainder of our cases, focal cal-



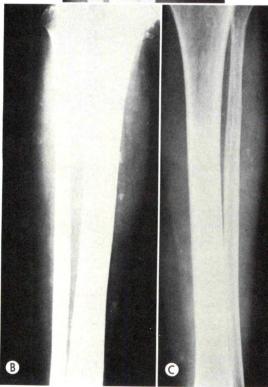


Fig. 2. (A-C) Anteroposterior views of right knee and lower legs show extensive calcification of skin and muscle.

cific deposits were noted in the deep soft tissues of the lower extremities. Case IX, included in this latter group, developed focal plaque-like calcifications in the left popliteal fossa during the course of her treatment (Fig. 4, A and B). Interestingly this occurred simultaneously with aseptic

necrosis of the left distal femur. No other areas of soft tissue calcification were demonstrated in this patient.

Although some of the patterns of calcification described in our series are reminiscent of those seen with hyperparathyroidism, none of our patients had clinical or laboratory evidence of either primary or secondary hyperparathyroidism, despite the frequent presence of renal insufficiency. The association in several of our patients of calcification with ulcerations and cutaneous eruptions points more to a dystrophic process, rather than to the metastatic calcification of normal tissues seen in hyperparathyroidism.

"Overlap" syndromes in patients with collagen disease have frequently been described. Thus, patients with the diag-



Fig. 3. Note calcific conglomerates in the peri-articular soft tissues (arrows) with preservation of normal mineralization and joint architecture.

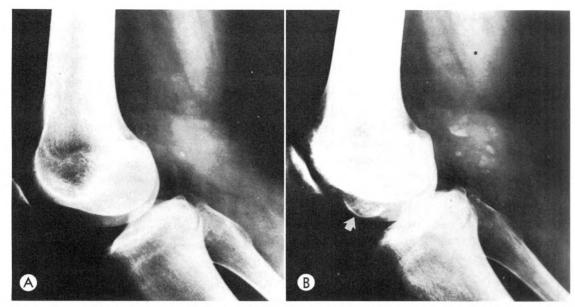


Fig. 4. (A and B) Lateral views of left knee at ages 18 and 23. Note initial absence and subsequent development of calcifications in the soft tissues of the popliteal fossa. Aseptic necrosis of the distal femur is also present as evidenced by an osteochondral fragment (arrow).

nostic features of SLE may have many characteristics of those with scleroderma or dermatomyositis. However, most patients in our series had classic manifestations of SLE. Although the marked joint involvement in Case II may suggest an overlap with rheumatoid arthritis, extensive soft tissue calcifications are certainly not a typical finding in the latter disorder.

It is tempting to regard the occurrence of calcinosis in the various connective tissue disorders as further evidence that they are merely individual expressions of the same pathologic spectrum. However, until the etiologic factors of these diseases are better understood, this concept would appear to be an oversimplification. In view of the fact that each of the connective tissue disorders usually possesses distinct histopathologic features, it is just as feasible to consider the process of dystrophic calcification as a nonspecific response to or result of damaged tissue.

Several mechanisms to explain the formation of this pathologic calcification have been proposed.<sup>4</sup> Local factors favoring soft

tissue calcification have been suggested. The increased alkalinity of necrotic tissues predisposes to precipitation of calcium salts. In addition, elevated levels of alkaline phosphatase, which may facilitate calcifications, have often been demonstrated in necrotic tissue. This phosphatase may be released by damaged lysosomes within the injured cells. Defective esterification of phosphate liberated by alkaline phosphatase may also lead to precipitation of calcium phosphate. Similarly, breakdown of substances able to bind calcium in a non-ionic form may be involved.

In any event, the causes of tissue damage leading to calcinosis may differ in SLE and the other collagen diseases. Infection, vasculitis and ischemia, autoimmune reaction at the cell membrane level, and fibrinoid replacement may all represent separate pathways to tissue necrosis and subsequent dystrophic calcification.

Although soft tissue calcifications were noted in 9 of 130 cases of SLE, the review was retrospective. The majority of cases had not had routine roentgenograms of the extremities. The actual incidence of soft

tissue calcinosis in SLE is, therefore, probably higher than that reflected in this report.

### SUMMARY

Calcifications in the skin and deeper soft tissues, although commonly associated with collagen disorders, have rarely been documented with SLE. This association, together with premature calcific deposits in the peripheral vasculature, probably occurs much more frequently than heretofore appreciated, may be roentgenographically discerned, and, in some instances, may predate the clinical and laboratory manifestations of the disease.

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### CONSTRICTIVE PERICARDITIS AND PROTEIN LOSING ENTEROPATHY\*

### AN IMITATOR OF INTESTINAL LYMPHANGIECTASIA

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ONSTRICTIVE pericarditis as a cause of protein losing enteropathy has received scant attention in the radiologic literature. The clinical presentation can be strikingly similar to intestinal lymphangiectasia, and the real, potentially fatal, but correctable cause of the patient's distress can be easily overlooked.

Protein losing enteropathy caused by chronic constrictive pericarditis was first reported by Jimenez-Diaz et al. in 19609 and independently by Davidson et al. in 1961.5 Since then at least 18 additional cases have been reported,1,5,13,15,21,26,27 although nearly always without mention of roentgenographic findings in the gastrointestinal tract.

In the past 15 years 5 patients with constrictive pericarditis and secondary protein losing enteropathy have been studied at the National Institutes of Health. Four of these had small bowel examinations. This, to our knowledge, represents the largest reported series of such patients from a single institution.

The purpose of this paper is to present the clinical and roentgenographic manifestations of this entity. In addition, we will demonstrate the complete reversal of roentgenographic abnormalities following pericardiectomy, a finding not previously reported. A typical case history of one of the patients is given.

### REPORT OF A CASE

CASE I. (R.B.) At age 14 this asymptomatic

white male developed abdominal cramps followed by explosive diarrhea with 5 or 6 episodes a day. A barium enema examination was normal. Hypoproteinemia was present, and intravenous Cr51 albumin showed increased protein loss into the gut. An exploratory laparotomy with liver and small bowel biopsies showed intestinal lymphangiectasia, and he was referred to N. I. H. with this diagnosis.

Physical examination showed brawny edema of the lower extremities, marked scrotal edema, a protuberant abdomen without definite evidence of ascites, and a scratchy Grade II/VI midsystolic murmur at the lower sternal border without radiation. Laboratory data included a normal hemogram and total white blood cell count but a depressed mean lymphocyte count of 533/mm.3 (normal 1,500-4,000/mm.3). Albumin was 1.3 gm. per cent, globulin 2.4 gm. per cent. Hypocalcemia was present (Ca++ 2.5 mEq./ml., P 5.6 mg. per cent).

Immunologic testing showed anergy to multiple antigens and inability to reject a skin graft from an unrelated donor.\*

Chest roentgenogram revealed normal cardiac size, pulmonary venous distention, mild interstitial pulmonary edema, and small bilateral pleural effusions. Fluoroscopy demonstrated diminished cardiac pulsations but no pericardial calcifications. Cardiac catheterization with cineangiocardiography demonstrated characteristic findings of constrictive pericarditis.

At operation a thickened and densely adherent pericardium was removed from the anterior and lateral portions of the heart. Final pathologic diagnosis was chronic pericarditis of un-

<sup>\*</sup> Immunologic aspects of this patient are reported more completely by Nelson et al.14

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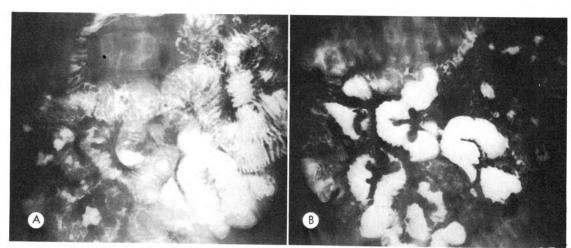


Fig. 1. Case 1. (A) Sixty minutes. Marked thickening of the folds of the duodenum, jejunum, and ileum, with dilution of the barium column. There is mild dilatation of the small bowel loops. (B) One hundred and fifty minutes. Segmentation is marked, indicating hypersecretion.

determined etiology. Over the next 6 months his edema disappeared, and his protein, calcium and total lymphocyte count returned to normal, as did his intestinal biopsy (Fig. 3, A and B).

Preoperative small bowel series (Fig. 1, A and B) showed the classic picture of intestinal lymphangiectasia: diffusely thickened mucosal folds throughout the jejunum and ileum, dilution of the barium column, and mild dilatation. On a repeat examination 19 months following surgery the small bowel was completely normal (Fig. 2). Clinically the patient was asymptomatic and had no abnormal laboratory findings.

### CLINICAL FINDINGS

Age range was 2 to 32 years. There were 4 males and 1 female (Table 1).

Edema was the most prominent presenting complaint in all 5 patients. Two had diarrhea. One of these experienced cramping abdominal pain with the episodes of diarrhea, but abdominal pain was not a feature in the other 4. Two of the 5 noted dyspnea on exertion but 2 others were probably too young (2 years and 5 II/I2 years) to evaluate the presence of this symptom. In constrictive pericarditis without hypoproteinemia, ascites is a more prominent finding than peripheral edema. Patients with secondary hypoproteinemia from other sources (e.g., protein losing enteropathy or nephrosis) manifest both peripheral

edema and ascites. Hence patients with constrictive pericarditis, protein losing enteropathy, and secondary hypoproteinemia show proportionally greater peripheral edema and less ascites than those with uncomplicated constrictive pericarditis. Only 1 of our 5 patients manifested ascites. Likewise, in intestinal lymphangiectasia the peripheral edema tends to be asymmetric, a finding which has been attributed to the associated dysplasia of systemic lymphatics. The peripheral edema which develops in protein losing enteropathy secondary to constrictive pericarditis is symmetric, affecting the lower extremities equally. This pattern was present in all 5 patients.

Tetany was present in 2 of the 5 patients, produced by hypocalcemia.

Anergy was present in the I case in which it was specifically looked for (R.B.). This condition reverted to normal following pericardiectomy. Another patient (T. H.) developed a positive tuberculin skin test  $3\frac{1}{2}$  months following pericardiectomy; the same test had been negative preoperatively. The postulated mechanism of anergy in these cases is leakage of lymphocytes into the gastrointestinal lumen from the dilated lymphatics, producing lymphocytopenia and anergy.<sup>23</sup>

All 5 patients had been evaluated in outside hospitals prior to referral to N.I.H. In 4 out of 5 the diagnosis of constrictive pericarditis was not suspected and was made at N.I.H. only after extensive evaluation.

In the 4 instances in which pericardiectomy was performed, there was marked clinical improvement with correction of the gastrointestinal protein loss and eventual return to clinical normality. The patient with the mildest clinical picture (F.L.) responded to medical management and no operation was performed. This was the only patient who did not have barium studies of the gastrointestinal tract.

One patient (T.H.) developed acute thrombosis of the superior vena cava during his hospitalization at N.I.H. This was demonstrated angiographically and successfully treated with thrombectomy at the time of pericardiectomy. The development of the thrombus was attributed to venous stasis.

### ROENTGENOGRAPHIC FINDINGS

The cardiac findings are outlined in Table II. The gastrointestinal findings are summarized in Table III. The roentgenographic manifestations of the condition are essentially those of intestinal lymphangiectasia. Findings were striking in I case (R.B.) and mild to moderate in the remaining 3. Demonstrable abnormalities included thickening of the mucosal folds, more prominently in the duodenum and jejunum than in the ileum, and manifestations of increased secretions (dilution of the barium, segmentation, and flocculation). Moderate dilatation was present in the most severe case (R.B.) and was minimal or absent in the other 3. In all cases the stomach and colon were normal.

No lymphangiogram was obtained in any of the 5 patients.

### PATHOLOGY

The gross and microscopic appearances of the small bowel are identical to those in intestinal lymphangiectasia, with small bowel mucosal edema and dilated serosal

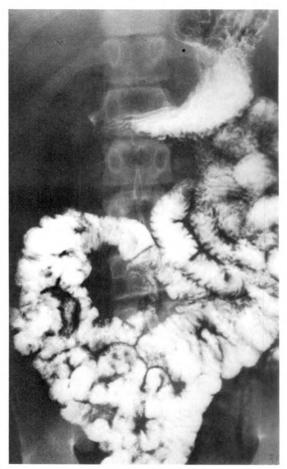


Fig. 2. Case 1. Nineteen months following pericardiectomy the small bowel is entirely normal.

and mesenteric lymphatics. Microscopically there are dilated lymphatic channels in the submucosa and serosa (Fig. 3, A and B).

### DISCUSSION

Exudation of protein into the gastrointestinal tract, subsequent breakdown into amino acids, and resorption of amino acids for re-use in protein synthesis occur to a minor extent as a normal physiologic process. In protein losing enteropathies the rate of serum protein loss into the gastrointestinal tract exceeds the body's synthesizing capacities. The result is hypoproteinemia. Albumin and gamma globulin are the most severely depressed protein fractions, since these have the slowest fractional rates of synthesis.

TABLE I
CLINICAL SUMMARY

		•										·
Case	Age (years) Sex	Peripheral Edema	As- cites	Diar- rhea	Tet- any	Total Protein gm. per cent	Albumin/ Globulin			I <sup>131</sup> PVP or Cr <sup>51</sup> Albumin Excretion %/4 Days (normals*†)	Duration of Illness	Response to Pericardiectomy
I. (R.B.)	15½ Male	+	_	+	+	3.7	1.4/2.3	2.25	533	22%†	1} yrs.	Rapid return to normal.
II. (E.B.)	23 Male	+	-	_	_	3.1	1.6/1.5	4.1		6.2%*	3½ yrs.	Significant improvement.
III. (D.M.)	5 11/12 Female	+	-		-	3.5	1.1/2.4	5.35	-	17.6%†	15 mo.	Steady improvement even- tually becoming normal.
IV. (T.H.)	2 0/12 Male	+	+	+	+	4.4	2.0/2.4			5.1%*	10 mo.	Rapid return to normal.
V. (F.L.)	32 Male	+		_	+	5.3	2.5/2.8	5.2		8%† (r day collection rather than usual 4 days)	12 mo.	No surgery—improved on medical management.

<sup>\*</sup> I<sup>131</sup> PVP- Normal excretion 0-1.5%/4 days. † Cr<sup>S1</sup> albumin-Normal excretion 0-0.7%/4 days.

detailed by Waldmann.26

Diagnosis of protein losing enteropathy depends on the appearance of excess radio-isotopically labeled macromolecules such as I<sup>131</sup> albumin, I<sup>131</sup> polyvinylpyrrolidone (I<sup>131</sup>PVP), Cr<sup>51</sup> albumin, or Cu<sup>67</sup> cerulo-plasmin in stool specimens following intravenous administration. The methods and pitfalls in interpreting results have been

Lymphocytopenia is a characteristic feature of the protein losing enteropathy of

constrictive pericarditis, and is seen also in intestinal lymphangiectasia, Whipple's disease, and occasionally in regional enteritis. It is due to loss of lymphocytes into the gastrointestinal lumen, and it leads to the characteristic anergy seen in these patients. Thus, a negative PPD does not rule out a tuberculous etiology of the pericarditis. A case in point is one of our patients (T.H.) with a negative tuberculin skin test who developed a positive skin test  $3\frac{1}{2}$  months

Table II
SUMMARY OF CARDIAC FINDINGS—ROENTGENOGRAPHIC AND CATHETERIZATION

Case	Pericardial Calcification	Cardiac Pulsations at Fluoroscopy	Cardiac Size	Cardiac Configuration	Pulmonary Vascular Congestion	Pleural Effusion	SVC Pressure At Cardiac Catheterization (cm. saline)	
I. (R.B.)	-	↓ LV pulsations	normal	normal	+	+ (bilateral)	19	
II. (E.B.)	+ *		normal	slightly prominent left auricle		+ (bilateral)	15	
III. (D.M.)	_	↓ LV and RV pulsations	slight cardiomegaly	nonspecific cardiomegaly	<del></del>	+ (bilateral)	22	
IV. (T.H.)	_	*	normal	normal	*****		28.7 (During superior vena cava throm- bosis)	
V. (F.L.)	_	normal	normal	normal		*****	14 (Mean right atrial pressure)	

<sup>\*</sup> Not performed.

+ = mild

TABLE III
ROENTGENOGRAPHIC FINDINGS

++= moderate

	Stomach	Duodenum	Jejunum				Ileum				Colon
		Fold Thickness	Fold Thickness	Dilata- tion	Dilution	Segmen- tation	Fold Thickness	Dilata- tion	Dilution	Segmen- tation	Fold Thickness
Case I.		<del></del>									
R.B. (Fig. 1, 2, and 3) Case II	0	+++	+++	++	+++	+++	+++	++	+++	+++	0
E.B. (Fig. 4 and 5) Case III	0	+	+	o	0	0	o	0	0	0	o
D.M. (Fig. 6 and 7) Case IV	0	++	++	0	0	0	++	0	0	0	o
T.H. (Fig. 8)	0	+	+	o	o	0	.0	0	o	0	o

following pericardiectomy, concomitant with the disappearance of the protein losing enteropathy and lymphocytopenia.

O = normal

Hypoproteinemia frequently accompa-. nies constrictive pericarditis. White28 in his 1935 St. Cyres lecture, reported total serum protein levels of less than 5.0 mg. per cent in 5 of 12 patients with constrictive pericarditis. Other reviews of constrictive pericarditis cite the incidence of hypoproteinemia at 20-50 per cent. Many explanations for decreased protein levels have been offered: (1) decreased albumin production by a congested liver; (2) malnutrition; (3) dilution of albumin by an increased plasma volume; (4) excessive protein loss through peritoneal punctures; or (5) degradation of serum protein by an unknown mechanism.10 Protein kinetic studies have definitely established that one mechanism is gastrointestinal protein loss. The role of other contributing mechanisms has not been completely defined as yet.

### PATHOPHYSIOLOGIC CONSIDERATIONS

The mechanism whereby protein losing enteropathy develops in constrictive pericarditis and other cardiac lesions is also not completely understood. Sustained systemic venous hypertension seems to be a prerequisite.<sup>23</sup> It has been shown both experimentally<sup>2,22,23</sup> and clinically<sup>6,16,23</sup> that increased systemic venous pressure will in-

crease lymphatic flow and lymphatic pressure in the thoracic duct. It is postulated that protein losing enteropathy is seen more commonly with constrictive pericarditis than with other cardiac lesions because constrictive pericarditis produces the highest venous pressures for the longest periods. However, elevated venous pressures are not the sole cause. Strober et al.<sup>23</sup> cite 7 patients with equally severe right heart failure and systemic venous hypertension who did not develop protein losing enteropathy.

+++= severe

Relative thoracic duct obstruction may also play a role in producing the syndrome. Takashima and Takekoshi<sup>24</sup> reported preand postoperative lymphangiograms on a 22 year old male with constrictive pericarditis and protein losing enteropathy. Preoperatively there was increased peripheral lymph flow as evidenced by rapid clearing of contrast from the lower extremities and by droplet formation of the oily contrast within the retroperitoneal lymphatics. The thoracic duct was dilated and tortuous. Postoperatively lymphangiography was normal save for narrowing of a terminal segment of the thoracic duct. They speculated that mild narrowing of the thoracic duct where it enters the venous system, unimportant at ordinary lymphatic flow rates, might constitute a relative obstruction under conditions of increased lymph-



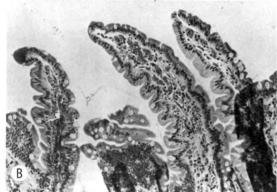


Fig. 3. Case I. (A) Preoperative intestinal biopsy reveals dilated lymphatics within the lamina propria. The picture is typical of intestinal lymphangiectasia (×20). (B) Six months following pericardiectomy the histologic appearance of the small intestine has returned to normal (×50). (Courtesy of D. Nelson and J. Pediat. 14)

atic flow, thus producing protein losing enteropathy.

### REVERSIBILITY OF THE CLINICAL SYNDROME

The time of recovery from protein losing enteropathy following surgical correction of the constrictive pericarditis is variable and reflects the pace of hemodynamic recovery. This is determined by the degree of myocardial atrophy and fibrosis which may occur during the period of constriction: the greater the atrophy, the more prolonged the recovery period; the greater the fibrosis, the more incomplete the long-term effectiveness of operation.<sup>11</sup> Reversion of the histologic findings of intestinal lymphangiectasia to normal has been reported as early as 5 weeks postoperatively.<sup>29</sup> If the venous pressure remains elevated, the

clinical and pathologic picture of intestinal lymphangiectasia will persist.<sup>16</sup>

The case reported above is the first demonstration of the complete reversibility of the abnormal roentgenographic gastro-intestinal pattern. The postoperative examination was performed 19 months after pericardiectomy. His serum protein, radio-active albumin turnover (which reflects the rate of albumin loss into the gut) and cardiac catheterization data had all returned to normal by the time of his first clinical visit 6 months postoperatively.

### DIFFERENTIAL DIAGNOSIS

While constrictive pericarditis is the cardiac lesion most commonly associated with protein losing enteropathy, other cardiac lesions have also produced a similar picture. All cardiac lesions producing excessive gastrointestinal protein loss are clinically obvious except constrictive pericarditis. These include familial cardiomyopathy, interatrial septal defect, pulmonic stenosis and tricuspid regurgitation. We have seen 4 patients at N.I.H. who have developed protein losing enteropathy secondary to tricuspid regurgitation (all secondary in turn to rheumatic heart disease). None of these had barium studies.

Protein losing enteropathy may develop with constrictive pericarditis of diverse etiologies. One of our cases presumably



Fig. 4. Case II. Prominent duodenal and proximal jejunal folds are noted. The gastric folds are normal.

was of tuberculous origin, while the other 3 in which surgery was performed were idiopathic. The development of protein losing enteropathy secondary to radiation-induced constrictive pericarditis has been reported following mediastinal irradiation for Hodgkin's disease<sup>27</sup> and chest wall irradiation for carcinoma of the breast.<sup>15</sup> The protein loss in this latter patient disappeared following pericardiectomy, as is usually the case.

The differential diagnosis of the "large fold" pattern associated with dilution on small bowel examination has been discussed extensively by others. 12,20 The entities most easily confused with protein losing enteropathy secondary to constrictive pericarditis are intestinal lymphangiectasia and hypoproteinemia from other sources (nephrosis, cirrhosis). Other considerations include Whipple's disease, amyloidosis, allergic gastroenteropathy, lymphomatous disorders, systemic mastocytosis, Zollinger-

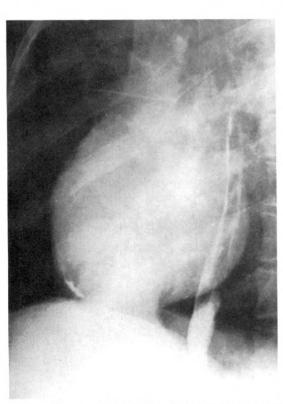


Fig. 5. Case II. Pericardial calcification is present; the pulsations were decreased at fluoroscopy.

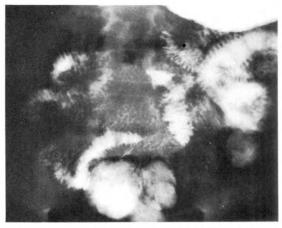


Fig. 6. Case III. Preoperative study demonstrates jejunum showing typical enlarged folds and dilution of barium. The findings cannot be distinguished from intestinal lymphangiectasia.

Ellison syndrome and nontropical sprue, although this last disease is most often associated with normal sized folds.

As with intestinal lymphangiectasia, the small bowel may appear completely normal in the presence of protein losing enteropathy secondary to constrictive pericarditis.

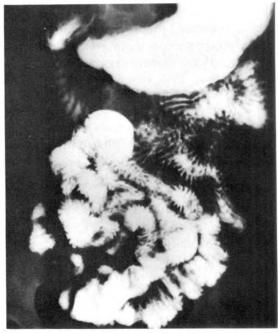


Fig. 7. Case III. Seven months postoperatively mild mucosal fold prominence persists, although there is less dilution. Clinically the patient was well, and the protein levels had returned to normal.



Fig. 8. Case IV. Slight prominence of the duodenal and jejunal folds is present, without dilution. The examination is only mildly abnormal.

In our series, each patient had been evaluated at outside institutions before referral to N.I.H. In all but one instance, the underlying cardiac abnormality had not been appreciated; this emphasizes the subtle nature of constrictive pericarditis as a clinical entity. The radiologist may be the first to suggest the diagnosis when encountering a pattern of intestinal lymphangiectasia in a patient with diarrhea or with known protein losing enteropathy. The chest should be fluoroscoped to look for evidence of pericardial calcification or decreased cardiac pulsations. Even lacking this roentgenographic evidence, the possibility of constrictive pericarditis should be raised and thoroughly investigated before being discarded, since this is a curable disorder, while intestinal lymphangiectasia is usually subject only to palliation.

The plain film, fluoroscopic, and angiocardiographic findings of constrictive pericarditis have been well outlined elsewhere.<sup>4,7,8</sup> Of note are the facts that pericardial calcification occurs in only half of patients with constrictive pericarditis, and that cardiac size is not always normal. The cardiac silhouette will be enlarged, either moderately or occasionally grossly, in roughly half of the patients. Cardiac pulsations at fluoroscopy are usually but not invariably diminished.

### SUMMARY

- 1. Constrictive pericarditis with secondary protein losing enteropathy can mimic intestinal lymphangiectasia exactly on both small bowel barium examination and small bowel biopsy.
- 2. Clinically, there is less ascites relative to the degree of peripheral edema than in uncomplicated constrictive pericarditis. The pattern of lower extremity edema is symmetric, unlike the asymmetric distribution more characteristic of intestinal lymphangiectasia.
- 3. Lymphocytopenia is present due to loss of lymphocytes into the gut. This produces anergy, which can mask an underlying tuberculous etiology of the constrictive pericarditis.
- 4. Constrictive pericarditis can be a subtle clinical entity. It should be carefully excluded in all cases where gastrointestinal roentgenographic studies and intestinal biopsy indicate intestinal lymphangiectasia.
- 5. Following surgical correction of the constrictive pericarditis, the clinical syndrome and its consequences can disappear. The abnormal small bowel roentgenographic pattern can revert completely to normal, as will small bowel biopsy.

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### SIMPLE METHOD OF DEPTH LOCALIZATION FOR TOMOGRAPHY\*

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THE purpose of this technique is to provide more accurate depth localization for pulmonary nodules than can be achieved by viewing stereoscopic or single lateral chest roentgenograms. This technique can probably be adapted to any tomographic device and allows localization of depth using simple devices that can be constructed in any shop. The method utilizes the principle of triangulation, which is well explained by Winkler and Cierzan.<sup>1</sup>

The essential part of this technique is the production of a distortion scale using geometry identical to that used in the production of the final localization films. The following steps are taken in production of this distortion scale.

- Saw a length of 2×2 inch wood, 25 centimeters long, with one end accurately square. Nail in the center of one side <sup>3</sup>/<sub>4</sub> inch brads, 1 cm. apart and covering a distance of 20 cm. or more from the square end (Fig. 1).
- 2. Using  $\frac{3}{8}$  inch plywood, make 2 pieces  $3.8 \times 55$  cm. and drill a  $\frac{1}{2}$  inch hole in one end of each piece. The holes are for storage on a hook. Make a third piece  $17 \times 38$  cm. and drill 2 holes along each of the long sides. These holes are used for lifting the piece of plywood out of the Bucky tray and for storage (Fig. 1). These measurements may vary slightly for different size Bucky trays.
- 3. Position an II×I4 inch cassette in the cassette tray using the wooden blocks as shown in Figure 2 to hold the cassette in a fixed position.
- 4. With the tomographic unit connected and the x-ray beam centered, place the 2×2 inch piece on its square end with the central ray of the vertical

- x-ray beam passing through the nails. The long axis of the nails should be perpendicular to the long axis of the table.
- 5. With the fulcrum of the tomographic unit set at zero and with the field at  $4\times12$  inches, in the long axis of the table, angle the tomographic unit 15 degrees toward the foot of the table (Fig. 3). This position is then noted and accurately marked on the x-ray equipment in some way so that the angle can be precisely duplicated at a later date. On our General Electric

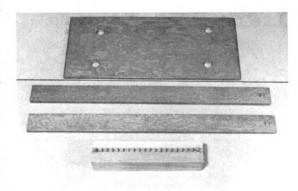


Fig. 1. Wooden block with nails and plywood pieces to hold 11×14 inch film in cassette tray.

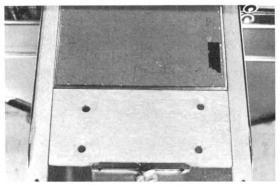


Fig. 2. An 11×14 inch cassette positioned in cassette tray.

<sup>\*</sup> From the Department of Radiology, St. Luke's Hospital, Kansas City, Missouri.

Ordograph, we simply note the number of inches the bridge is shifted from the vertical position. On our Picker ITTL, we made a mark on the upper tube-stand bearing bar. An exposure of the nails is then made at this angle.

- 6. The IIXI4 inch cassette is then shifted to the opposite side of the cassette tray as shown in Figure 4. With the fulcrum still set at zero, the tube is shifted so that the tube is angled 15 degrees toward the head of the table (Fig. 4). The amount of shift is again noted, so that it can be duplicated, and an exposure is made.
- 7. This film is developed and the distortion scale is made by placing a piece of clear IIXI4 inch x-ray film squarely over the doubly exposed film (Fig. 5) and placing lines on the I, 5,

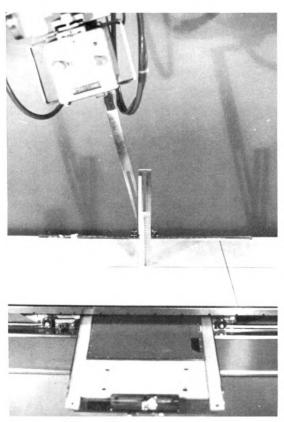


Fig. 3. Cassette positioned with tube angled toward feet.

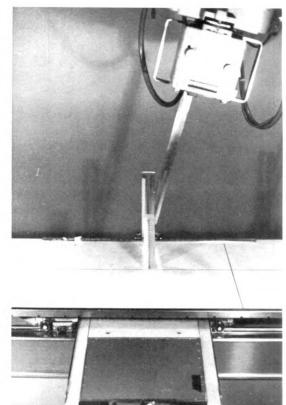


Fig. 4. Cassette positioned with tube angled toward head.

10, 15, and 20 cm. nails on both sides of the zero level. Parallel lines perpendicular to the side of the film are drawn. See Figure 6 for the completed scale

When examining a patient by tomography, 2 exposures are made in exactly the same manner as described above. The suspected lesion is projected as accurately as possible in the path of the central ray. In addition, we routinely take a low KV well coned tomographic scout film at a depth that the technician feels is the best guess as to where the lesion is using the factors that are considered optimum. These 2 films are then reviewed and from them is obtained the depth of the lesion using the distortion scale centered on the lesion with the edges of the distortion scale and the 11 X 14 inch film being parallel. Additionally, adjustments in roentgenographic tech-

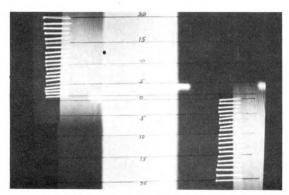


Fig. 5. Double exposed film showing nails with distortion scale drawn on superimposed clear film.

nique are made from the scout film. It is not necessary that the level of the scout film supass through the lesion.

The following case illustrates the value of this technique. A very small and barely perceptible lesion was noted in the left apex. The depth localizing film with the

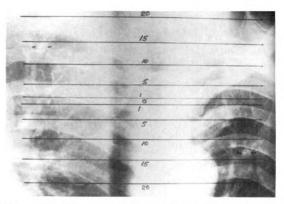


Fig. 7. Double exposed film with superimposed and centered distortion scale indicating depth of lesion at about 14 cm.

superimposed distortion scale showed the lesion at approximately  $1_4$  cm. (Fig. 7). The scout tomogram revealed proper exposure, and cuts were made through this lesion at  $\frac{1}{2}$  cm. intervals from 13 to 15 cm. The best film is shown in Figure 8 and re-

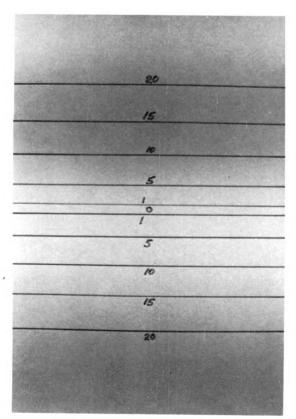


Fig. 6. Completed distortion scale.



Fig. 8. Best cut at 13.5 cm.

magazina . m .

veals several small punctate calcifications within the lesion. Note that the final definitive films were based on only 2 preliminary films using 3 exposures.

The lesion was excised and the pathologic examination revealed an inactive granulomatous lesion as indicated by the tomo-

grams.

One must keep in mind that the depth of the lesion is somewhat dependent upon the phase of respiration, so that it is important to instruct the patient to hold his breath at the same point each time. This is true especially in the lower lung fields.

This technique has been used in our de-

partment over the past 3 years and has been most helpful in obtaining high quality, well positioned and localized tomographic views of small pulmonary nodules with maximum economy of patient exposure and film usage.

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### POTENTIAL SOURCES OF ERROR IN CORONARY ARTERIOGRAPHY\*

### I. IN PERFORMANCE OF THE STUDY

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In performing coronary arteriography, the angiographer has two principal concerns. The first and foremost is for the safety of his patient. The risks and complications of this procedure have been discussed by Adams et al.¹ and we will not deal specifically with this topic. The second concern is the performance of a technically optimal study which demonstrates coronary artery anatomy and pathology precisely and unequivocally.

There are a number of potential sources of error which may interfere with achievement of the latter goal. These must be recognized and dealt with appropriately while the procedure is in progress so that serious misdiagnosis can be avoided. This paper will deal with these pitfalls and is based upon a clinical experience of approximately 1,000 coronary arteriograms and left ventriculograms performed by the percutaneous femoral approach. Catheters of the Judkins design8 were generally utilized, although in a number of instances those of the Amplatz design<sup>3</sup> also proved useful. Both cine filming and rapid serial roentgenograms were routinely obtained. Constant monitoring of the arterial pressure at the tip of the catheter was carried out in all cases by means of a Statham P23db strain gauge transducer and an Electronics for Medicine DR-8 oscilloscopic recorder.

The most important potential sources of error encountered in the performance of these studies were anomalous origins of vessels, absence or early bifurcation of the main left coronary artery, main left coronary artery stenosis, separate origin of the conus artery from the right sinus of Valsalva, eccentric plaques seen in only one projection, and spasm of vessels.

### I. ANOMALOUS ORIGINS OF CORONARY ARTERIES

Anomalous origins of the coronary arteries which cause no interference with normal hemodynamics will be incidentally discovered from time to time in adult patients undergoing coronary arteriography. These variations, which have been described pathologically by previous authors, 2,15,19 are of little clinical significance aside from the extent to which they prove confusing to the angiographer.

Among a series of over 18,000 autopsies performed in the 1940s2 on patients without congenital heart disease, 45 such cases were encountered, an incidence of approximately 2.5 per thousand. In our experience, the incidence has been more than twice as high. The most common anomalies are origin of the circumflex artery from the right coronary artery (RCA) or right sinus of Valsalva, origin of the left anterior descending artery (LAD) from the RCA or right sinus of Valsalva, origin of all 3 coronary arteries from either the right or left sinus via 2 or 3 separate ostia, single coronary artery, and high ectopic location of either the right or left coronary ostium well above its normal position in the sinus.

Figure 1 is a case of origin of the circumflex artery from the RCA. We have seen 3 examples of this and in each instance, the circumflex artery arose immediately be-

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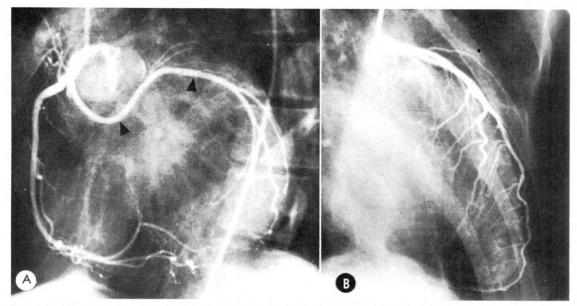


Fig. 1. (A) Right coronary arteriogram, left anterior oblique (LAO) view. The left circumflex artery (black arrowheads) arises from the most proximal portion of the RCA and courses behind the aorta to reach its usual position in the left atrioventricular groove. (B) Left coronary arteriogram, right anterior oblique (RAO) view. The LCA gives rise only to the LAD branch.

yond the right coronary ostium. If the right coronary catheter is allowed to slide too far into the RCA before the injection is made, this type of anomalous circumflex artery may not be visualized.

Figure 2 is an example of origin of all 3 coronary arteries from the right sinus via 3 separate ostia.

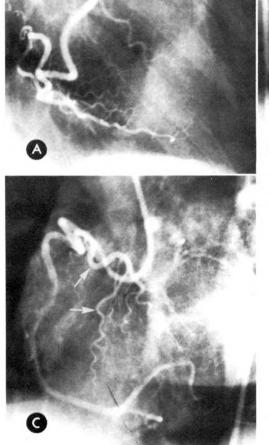
When a vessel cannot be found in its usual location and variations like these are therefore suspected, non-selective injections into the aortic sinuses may have to be performed to identify the ectopic ostium. Cine supravalvular aortograms may be necessary in some cases, especially when high ostia are present. Selective entry into an ectopic ostium may be facilitated by switching from the Judkins to the Amplatz catheter, or *vice versa*, if probing with the first catheter fails to locate it.

### 2. ABSENCE OR EARLY BIFURCATION OF THE LEFT MAIN CORONARY ARTERY

Anatomic studies by various authors<sup>7,19</sup> have shown that in 1 per cent of normal human hearts, a main left coronary artery

(LCA) is absent. In such instances, its 2 major branches, the LAD and circumflex arteries, arise from separate ostia which lie side by side in the left sinus of Valsalva. In other instances, a very short main LCA is present which extends for only 2-3 mm. before bifurcation occurs. During coronary arteriography in such patients, the tip of the left coronary catheter will generally pass "superselectively" into one or the other of these 2 branches without the angiographer realizing it. Unless there is considerable reflux of contrast material into the left sinus of Valsalva, the resulting arteriogram will show opacification of only that branch, suggesting total obstruction at the origin of the other.

Figure 3A is a left coronary arteriogram in which the LAD failed to opacify and might therefore be presumed to be totally obstructed. There was no collateral circulation from either the RCA or left circumflex artery. Cine left ventriculography in the right anterior oblique projection showed normal contractility of the entire left ventricle (LV). If the LAD was actually



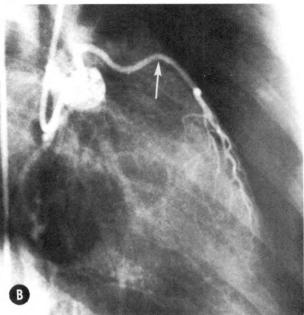


Fig. 2. (A) Right coronary arteriogram, RAO view. The LCA could not be found in its usual position in this patient. The RCA is well-filled and there is some reflux of contrast out into the right sinus of Valsalva. This results in faint opacification of anomalous LAD (white arrowheads) and circumflex (black arrowhead) arteries which arise from the right sinus. (B and C) RAO and LAO views of selective injections into the anomalous LAD (white arrows) arising from the right sinus. There is some reflux of contrast material with partial opacification of the RCA. The circumflex artery was not selectively catheterized.

totally obstructed with complete absence of collateral circulation, it is highly unlikely that normal contractility of the anterior wall of the LV could be preserved. In such a situation, the affected portion of LV myocardium almost always shows a severe degree of dysfunction during ventriculography. This was the clue which indicated that superselective catheterization of the circumflex artery had inadvertently occurred, due either to absence or early bifurcation of the main LCA. After insert-

ing a left coronary catheter of a different shape and probing for a short period of time, the separate LAD ostium was successfully located (Fig. 3B). We have encountered problems of this sort in approximately 2 per cent of our studies. The presence of a perfectly normal left ventriculogram in the face of an apparent total occlusion of one of the two major left coronary branches without visible collateral circulation should suggest to the angiographer that this anatomic variant is present

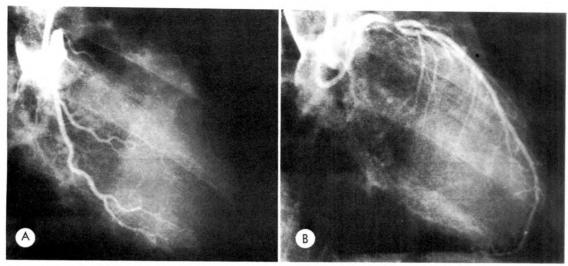


Fig. 3. (A) Initial left coronary arteriogram, RAO view. Only a circumflex branch is visualized, suggesting possible LAD occlusion. (B) After further searching with a catheter of a different shape, this LAD was entered immediately adjacent to the origin of the circumflex artery. Severe proximal stenosis is seen. There is either absence or early bifurcation of the main LCA.

and that superselective catheterization has occurred.

## 3. MAIN LEFT CORONARY STENOSIS

Stenosis of the main LCA proximal to its bifurcation is the most ominous of all coronary lesions. A recent review of 32 such cases by Cohen *et al.*<sup>4</sup> revealed a 50 per cent 2 year mortality rate among those treated medically. Five of their patients died as a direct result of the angiographic procedure, presumably due to dissection or occlusion as the catheter tip entered the stenotic main LCA.

Even when selective catheterization of such vessels is accomplished without incident, the tip may inadvertently be passed beyond the stenotic segment. If so, the arteriogram can appear entirely normal. The fact that the catheter tip has actually traversed a stenosis may be signified by a decrease in pressure in the LCA. Monitored pressure at the catheter tip frequently falls during right coronary catheterization due to spasm or small size of the artery, but this rarely occurs after uncomplicated entry into a non-stenotic LCA. Another more definitive clue suggesting main LCA stenosis in the face of an apparently normal

arteriogram is collateral circulation from the RCA to branches of the LCA. Collateral circulation from one major artery to another is virtually never seen unless there is at least 90 per cent stenosis of the recipient vessel.<sup>11</sup>

Stenotic lesions of the main LCA are best demonstrated by a non-selective contrast material injection into the left sinus of Valsalva just outside the left coronary ostium with the patient in the left anterior oblique position.

Figure 4 is a case in which an apparently normal LCA was seen initially. It was noted, however, that arterial pressure decreased somewhat when the catheter passed from the aorta into the left coronary ostium. When the right coronary arteriogram was performed, it revealed extensive collateral supply to the LCA. Because of these findings, main LCA stenosis was strongly suspected. A repeat injection of contrast material into the left sinus of Valsalva with the patient in the left anterior oblique position confirmed the presence of severe narrowing just beyond the origin of the main LCA.

These lesions may also be suspected in advance on clinical grounds, if there is a

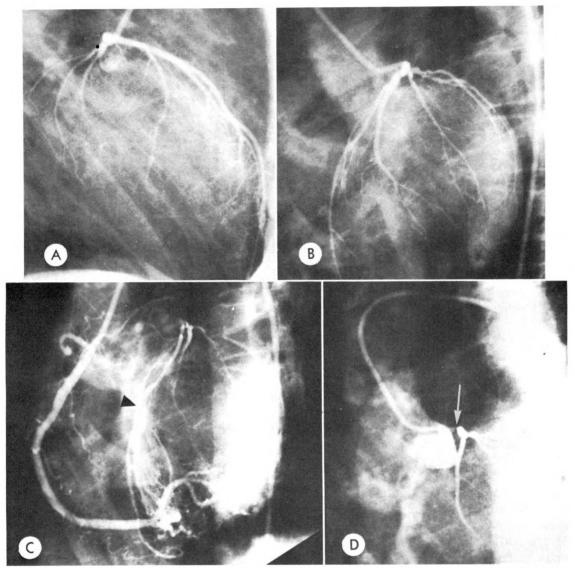


Fig. 4. (A and B) Initial RAO and LAO views of an apparently normal left coronary arteriogram. (C) Right coronary arteriogram, LAO view. There is extensive collateral circulation from the RCA to the LCA. Most of the flow is from the posterior descending branch of the RCA through the interventricular septum and around the apex to the LAD (black arrowhead). (D) Injection of contrast into the left sinus of Valsalva, LAO view. In actuality, this patient has severe localized stenosis at the origin of the main LCA (white arrow). The catheter tip had passed through this stenosis at the time of the initial left coronary arteriogram and it therefore was not visualized.

history of angina decubitus<sup>5</sup> or a profound ischemic response to a double Master's test,<sup>4</sup> although these findings are by no means pathognomonic.

4. SEPARATE ORIGIN OF THE CONUS ARTERY FROM THE RIGHT SINUS OF VALSALVA

In approximately half of all human

hearts, the conus artery arises as the first branch of the RCA and supplies the outflow portion of the right ventricle. In the other half, it arises from a small separate ostium in the right sinus of Valsalva very close to the main right coronary ostium.<sup>7,18</sup> Although the conus artery has a relatively small area of distribution, it may serve as

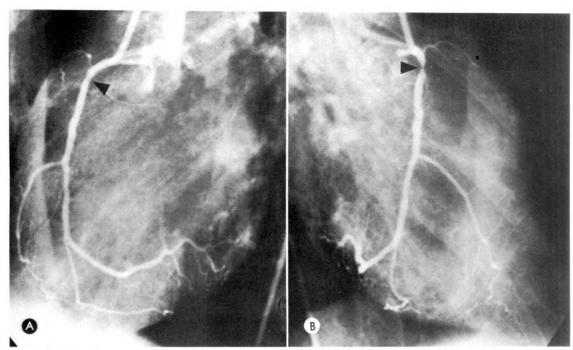


Fig. 5. (A) Right coronary arteriogram, LAO view. The stenosis in the proximal portion of the artery indicated by the black arrowhead appears to be of relatively mild degree. (B) Right coronary arteriogram, RAO projection. With this 90 degree rotation of the patient, the same lesion is seen to actually produce a severe localized narrowing of the proximal RCA.

a significant source of collateral circulation to the LAD when the latter is obstructed.<sup>11</sup>

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Frequently during selective RCA catheterization, the tip of the catheter tends to pass more than I or 2 cm. into the artery. With the tip this far into the vessel, most of the injected contrast material flows in the antegrade direction with little or no retrograde reflux into the right sinus. It is quite possible in this situation that a conus artery having a separate origin in the sinus would fail to opacify. In patients with LAD obstruction, filling of the distal segment via this important collateral pathway might thus not be appreciated. This is of more than purely academic interest, since it has been shown that the feasibility of coronary bypass surgery correlates strongly with the amount of flow which can be demonstrated angiographically in the distal segment of an obstructed vessel. 9,10,17

In general, when LAD obstruction is present, a definite attempt should be made to visualize the conus artery. If selective right coronary arteriography does not accomplish this, a non-selective injection into the right sinus of Valsalva will usually fill the separate conus ostium. Selective catheterization of the conus artery itself is tedious and time-consuming and should not be attempted routinely.

# 5. ECCENTRIC ATHEROSCLEROTIC LESIONS

More often than not, atherosclerotic plaques within the coronary arteries are eccentrically positioned.<sup>19</sup> The resulting lumen may be crescentic or slit-like. If the x-ray beam happens to pass perpendicular to the plane of such a lumen, it may appear to have a normal or nearly normal caliber.

Figure 5A is a right coronary arteriogram in the left anterior oblique projection showing what appears to be a mild stenosis of the proximal portion of the RCA. The right anterior oblique view (Fig. 5B) of the same artery shows that very severe localized narrowing is actually present. This emphasizes the importance of obtaining

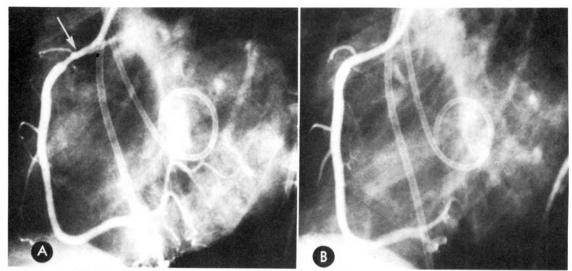


Fig. 6. (A) Right coronary arteriogram, LAO view. An apparently severe localized narrowing of the artery (white arrow) is seen adjacent to the tip of the catheter on this initial injection. (B) Repeat study 5 minutes after sublingual nitroglycerin. The same segment of the RCA now appears normal, indicating that the narrowing seen initially had been due to spasm.

arteriographic views in at least 2 projections 90 degrees apart. Failure to do so can lead to serious underestimation of the degree of disease present.

# 6. SPASM OF VESSELS

Introduction of a catheter into the right coronary ostium occasionally induces significant spasm of the proximal portion of the artery. For reasons which are not entirely clear, this rarely occurs on the left side. Narrowing due to spasm may have an angiographic appearance identical to that of localized atherosclerotic disease, but the two can readily be differentiated by the use of a coronary vasodilator such as nitroglycerin.

Figure 6A is a right coronary arteriogram showing an apparent severe narrowing of the proximal RCA. Five minutes after sublingual administration of 0.4 milligrams of nitroglycerin, the study was repeated and revealed that the vessel was actually entirely normal (Fig. 6B). This drug should be given and a repeat injection performed any time selective coronary arteriography demonstrates a narrowed segment adjacent to the tip of the catheter, especially when the RCA is involved. At

times, spasm can be quite persistent and 2 or even 3 tablets may be required to counteract it.

The vasodilatory effect of nitrates upon the major coronary arteries has been recognized for many years<sup>13,20</sup> and was originally thought to be the mechanism responsible for the relief of angina. Recent reports<sup>6,14,16</sup> have shown, however, that nitrates produce a variety of other hemodynamic effects which may play a more important therapeutic role. These include reductions of systemic arterial pressure, left ventricular volume, left ventricular end-diastolic pressure, myocardial wall tension and left ventricular ejection time.

#### SUMMARY

Certain relatively common potential sources of error may be encountered during the performance of coronary arteriograms. These result from anomalous origins of vessels, absence or early bifurcation of the main left coronary artery, main left coronary artery stenosis, separate origin of the conus artery from the right sinus of Valsalva, eccentric plaques seen in only I projection, and spasm of vessels. Recognition of these situations is discussed and

suggestions are made as to how to deal with them while the procedure is in progress.

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# POTENTIAL SOURCES OF ERROR IN CORONARY ARTERIOGRAPHY\*

# II. IN INTERPRETATION OF THE STUDY

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N 1962, Eusterman et al.3 compared estimated degree of arterial narrowing on postmortem coronary arteriograms with actual degree of narrowing of the same vessels as determined by serial sectioning. They found significant discrepancies in fully 39 per cent of their cases, with arteriography underestimating the extent of disease in 22 per cent and overestimating it in 17 per cent. More recently, Vlodaver et al.14 studied the coronary arteries at autopsy of patients who had undergone arteriography shortly before death and found significant discrepancies in 36 per cent. In both series, arteriographic underestimation became more common as the severity of disease increased. These statistics are a serious indictment of our ability to accurately interpret coronary arteriograms.

The potential sources of error in performance of these procedures have been previously discussed. 10 This paper will deal with potential sources of error in the interpretation of coronary arteriograms, in the hope that familiarity with these situations will improve diagnostic accuracy in the future.

Among a series of approximately 1,000 studies, the most likely areas of interpretative error were found to be superimposition of other arteries upon the left anterior descending artery, non-dominance of the right coronary artery, anatomic variations in the distribution of the posterior descending artery, myocardial bridging, recanalization of arterial thrombi, and small vessel obstruction. As James has pointed out,7 it is quite likely that the incidence of error

will prove to be inversely related to the experience of the angiographer.

# I. SUPERIMPOSITION OF OTHER ARTERIES UPON THE LEFT ANTERIOR DESCENDING ARTERY

In terms of anatomic position and distribution, the left anterior descending artery (LAD) is the most constant of the major coronary arteries. The vessel courses forward along the length of the anterior interventricular groove at least as far as the cardiac apex. Generally, it passes the apex, then turns posteroinferiorly and terminates along the diaphragmatic surface of the heart. During its passage along the anterior interventricular groove, it supplies important branches to the free wall of the left ventricle (diagonal branches) and the interventricular septum (septal branches). These diagonal and septal arteries may at times run parallel to and superimposed upon the LAD in certain projections, thereby obscuring obstruction of the latter vessel.

Figure 1 demonstrates a relatively common anatomic arrangement, in which a large diagonal branch arises from the proximal LAD and passes over the free wall of the left ventricle (LV). Its course closely parallels that of the LAD in both oblique projections. It is quite apparent that total LAD obstruction just beyond the origin of the diagonal branch could be completely overlooked if the interpreter was to mistake the diagonal branch for the parent

Figure 2 is a case of complete obstruction

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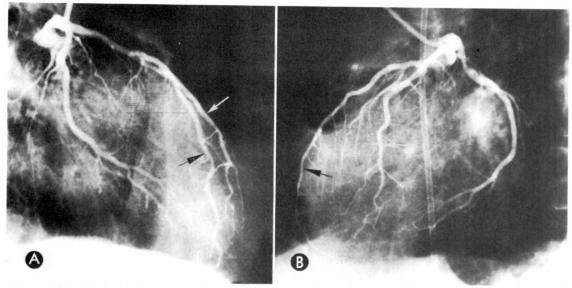


Fig. 1. (A and B) Left coronary arteriogram, RAO and LAO views. The LAD (black arrows) gives rise to a large diagonal branch (white arrows). The 2 vessels closely parallel each other and the diagonal branch might easily be mistaken for the LAD if the latter was occluded. Note that the LAD passes completely around the cardiac apex to terminate along the diaphragmatic surface of the heart and that it gives rise to a number of small vertically oriented septal branches. These are distinctive anatomic features which allow the LAD to be differentiated from a diagonal branch.

of the LAD. An enlarged septal branch arises just proximal to the lesion. In the left anterior oblique (LAO) view of the left coronary artery (LCA), this septal branch is superimposed directly upon the course of

the LAD and could readily be mistaken for the obstructed parent vessel. The right anterior oblique (RAO) view demonstrates, however, that the opacified vessel lies posterior to the apex of the heart and that it is

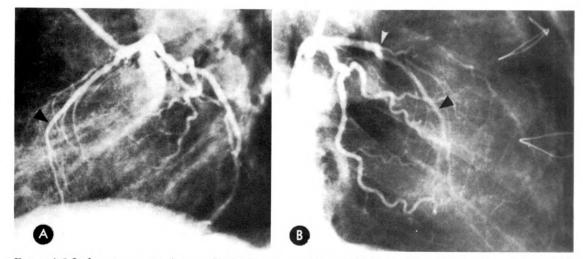


Fig. 2. (A) Left coronary arteriogram, LAO view. A vessel is seen (black arrowhead) following a course which appears to be that of the LAD. (B) Left coronary arteriogram, RAO view. The same vessel is now seen to lie in the interventricular septum well behind the cardiac apex. The LAD is actually completely obstructed (white arrowhead). The septal branch has enlarged in an attempt to supply collateral circulation to the anterior portion of the septum.

therefore within the interventricular septum rather than upon the epicardial surface.

Failure to recognize an LAD obstruction in such cases can be avoided if one bears in mind the principal identifying features of this vessel—that it extends all the way around the cardiac apex, that it gives off a number of straight and vertically oriented septal branches, and that it is located in the anterior interventricular groove which lies roughly in the midline of the heart in a shallow LAO projection. An important functional clue to the presence of an undetected LAD (or diagonal) obstruction may be the presence of an anterior LV aneurysm in the face of what appears to be a normal left coronary arteriogram.

# 2. NON-DOMINANCE OF THE RIGHT CORONARY ARTERY

In approximately 90 per cent of human hearts<sup>6</sup> the right coronary artery (RCA) is a large caliber artery which passes all the way around the right atrioventricular groove to the crux of the heart (the junction of the right and left atrioventricular grooves and the posterior interventricular groove) where it terminates by giving rise to the posterior descending and posterior left ventricular branches. This has been referred to as right coronary "dominance." In the remainder of cases, the posterior descending and posterior left ventricular branches arise from the left circumflex artery; here the LCA is considered dominant.

The non-dominant RCA does not perfuse any of the diaphragmatic surface of the LV and consequently, after giving off marginal branches to the right ventricle, its distal segment becomes very narrow and fails to reach the crux. This is shown in Figure 3. Such a vessel should not be assumed to be diseased—its narrow distal caliber is due entirely to congenital hypoplasia. This is confirmed if the left coronary arteriogram clearly shows the posterior descending and posterior left ventricular branches arising from the left circumflex artery.

LCA dominance may be mimicked oc-

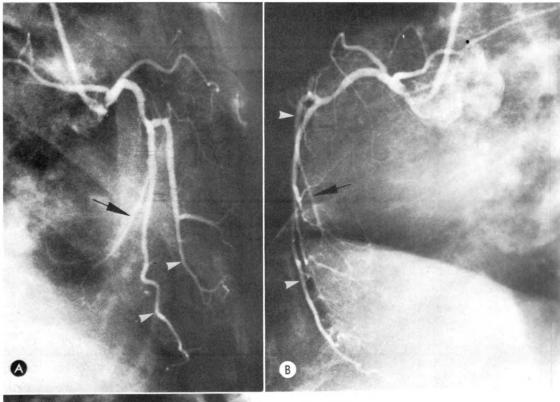
casionally if the distal left circumflex artery supplies collateral circulation to the posterior descending and posterior left ventricular branches of an obstructed dominant RCA. The tortuosity and irregularity of the collateral channels should differentiate this condition from LCA dominance, in which the posterior descending and posterior left ventricular branches take natural anatomic origin from the left circumflex artery.

# 3. ANATOMIC VARIATIONS IN THE DISTRIBU-TION OF THE POSTERIOR DESCENDING CORONARY ARTERY

According to commonly accepted anatomic teaching, the posterior descending artery arises from the dominant coronary artery (usually the RCA) at the crux of the heart. It passes forward along the posterior interventricular groove toward the cardiac apex and supplies the diaphragmatic aspects of the interventricular septum and LV. A recent study showed, however, that in 15 per cent of patients with right coronary dominance, part of the blood supply of this important region originated not from the posterior descending artery, but rather from posterior right ventricular or acute marginal branches of the RCA. These branches arise from the RCA well before it reaches the crux.

Figure 4 is an example of such a variant. The posterior descending artery in such cases may be congenitally short and supply only a small area. This should not be mistaken for atherosclerotic disease.

On occasion, a patient with a patent RCA and posterior descending branch may have a history of diaphragmatic myocardial infarction or a dyskinetic segment of the diaphragmatic LV. This paradox can occur if there is unrecognized obstruction of posterior right ventricular or acute marginal branches of the RCA which supply parts of the diaphragmatic aspect of the septum or LV. These branches are often not closely inspected because they are distributed primarily to the right ventricle, an area of relatively little importance in human coronary artery disease.



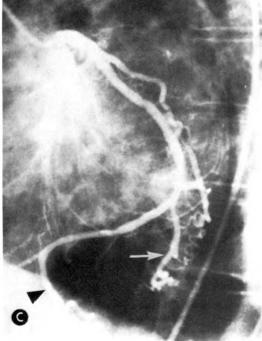


Fig. 3. (A and B) Right coronary arteriogram, RAO and LAO views. Large marginal branches (white arrowheads) pass along the lateral aspect of the right ventricle. Beyond their origins the RCA (black arrows) is small and does not reach the area of the crux. (C) Left coronary arteriogram, in the same patient, LAO view. The posterior descending (black arrowhead) and posterior left ventricular branches (white arrow) arise from the circumflex artery, indicating left coronary dominance. In this anatomic pattern, the distal RCA is congenitally small.

# 4. MYOCARDIAL BRIDGING

The major coronary arteries are located in grooves along the epicardial surface of the heart. On occasion, they may dip into the myocardium for distances of 3-30 mm. Since these short arterial segments are covered by myocardial fibers, the condition has been referred to as myocardial bridg-

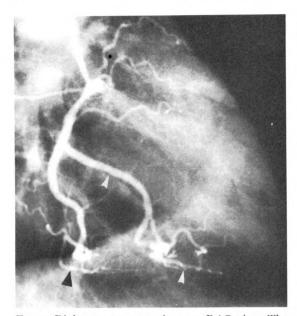


Fig. 4. Right coronary arteriogram, RAO view. The mid-diaphragmatic portion of the interventricular septum is supplied by a large marginal branch (white arrowheads) which originates from the proximal RCA. The posterior descending artery (black arrowhead) originates normally at the crux but is quite small since it only supplies the posterior aspect of the septum.

ing. The incidence, as reported in autopsy series, varies widely. Edwards *et al.*<sup>2</sup> noted it in 5.4 per cent of cases, whereas Polacek and Kralove<sup>12</sup> reported its presence in as many as 86 per cent. The LAD is by far the most commonly affected vessel.

The angiographic appearance of myocardial bridging was first described in dogs by Bloor and Lowman.¹ The intramyocardial segments show transient narrowing, generally during systole, followed by rapid return to normal caliber. This is due to phasic contraction and relaxation of the overlying muscle fibers. Although the intramyocardial segments can develop athersclerotic lesions just like other portions of the coronary arteries,² the *transient* narrowings associated with bridging should not by themselves be misconstrued as stenoses.

Figure 5 is an example of bridging of the LAD. In our experience, this phenomenon is rarely encountered angiographically, thereby supporting the statistics of Edwards *et al.*<sup>2</sup>

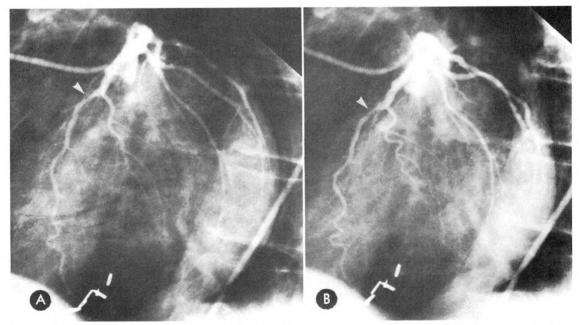


Fig. 5. (A) Left coronary arteriogram, LAO view. There is an apparent severe localized narrowing (white arrowhead) of the LAD. (B) Slightly later during the same sequence, the segment in question shows a wider caliber, although diffuse atherosclerotic plaque formation is present. The transient nature of this narrowing indicates that it is due to myocardial bridging. Bridges are usually best seen on cineangiograms.

# 5. RECANALIZATION OF CORONARY ARTERIAL THROMBI

Recanalization of occlusive coronary artery thrombi occurs much more frequently than is generally appreciated. In an autopsy study of 25 cases with clinical coronary artery disease, Snow et al.<sup>13</sup> discovered recanalization in 17 of 41 main vessel occlusions. A similar study by Friedman<sup>4</sup> revealed recanalization in 30 of 75 occluded segments. In one-third of recanalized segments in the latter study the aggregate diameter of the luminal channels exceeded 50 per cent of the diameter of the artery itself.

Figure 6 is a right coronary arteriogram showing severe localized narrowing of the midportion of the vessel with good distal flow. Previous arteriography performed a year earlier had shown total occlusion at the same level. The patient expired 8 days after the second study and careful postmortem examination revealed that the narrowed RCA segment was a recanalized thrombus. This case illustrates the difficulty in angiographically distinguishing the postocclusive recanalized thrombus from the pre-occlusive atherosclerotic stenosis. A casually-made diagnosis of "localized stenosis" of a coronary artery can be misleading, since this implies that complete obstruction has not yet occurred. Localized coronary artery narrowing with good distal runoff is often seen in patients with angina who have no history of infarction or evidence of regional LV dysfunction on ventriculography. Less frequently, narrowing of the same degree occurs in patients with a definite history of infarction and visible dvsfunctional segments of LV myocardium. The reasons for this discrepancy are not entirely clear, but it is conceivable that the coronary lesions in the latter group may actually be recanalizations of previously occluding thrombi.

# 6. SMALL VESSEL OBSTRUCTION

Much attention has been focused in recent years on the puzzling group of patients

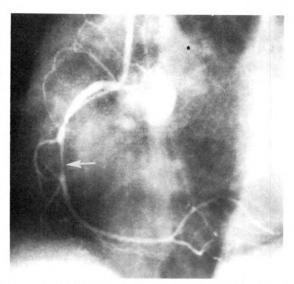


Fig. 6. Right coronary arteriogram, LAO view. Localized narrowing of the mid-portion of the artery is present (white arrow). At autopsy this was found to be a recanalized thrombus. It would be very difficult to arteriographically distinguish this from an atherosclerotic stenosis which has not yet become obstructed.

who have strong clinical evidence of coronary artery disease with apparently normal coronary arteriograms.7,11 Some authors have raised the possibility that this may be explained by small vessel disease which is not recognized angiographically.5,7 Although this matter has not yet been adequately resolved, it emphasizes the importance of adequate visualization of the small coronary artery branches (I mm. or less in diameter). One of the chief difficulties in recognizing obstruction of these vessels is the fact that they are variable in number, size and distribution. Small posterior left ventricular, diagonal or obtuse marginal arteries may not even be missed by the interpreter if they are completely obstructed at their origins from major arteries. Certain clues may help in recognition of such lesions. These include visualization of a small stump at the origin of the occluded branch and retrograde filling of the distal segment via collateral circulation. Left ventriculography may provide indirect evidence by demonstrating localized myocardial akinesia or dyskinesia in the dis-

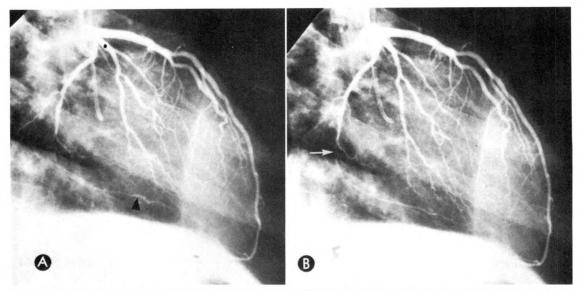


Fig. 7. (A) Left coronary arteriogram, RAO view. No major proximal obstructions are present. There is, however, retrograde filling of a small posterior left ventricular branch (black arrowhead) via collateral circulation. (B) Slightly later during the same sequence, further retrograde opacification outlines the obstruction (white arrow) of this terminal posterior left ventricular branch of the left circumflex artery. Because of variability in the anatomy of small vessels such as posterior left ventricular branches, it is doubtful that this obstruction would have been discerned if retrograde filling of the distal segment had not occurred via collateral circulation.

tribution of the affected vessel.

Figure 7 is an example of obstruction of a small posterior left ventricular branch of the left circumflex artery diagnosed only because of retrograde filling of the distal segment by collateral circulation. The patient had a history of diaphragmatic myocardial infarction and no other discernible coronary lesions.

James 8 has pointed out that small coronary arteries may occasionally be affected by a variety of disease processes other than atherosclerosis. These include emboli from subacute bacterial endocarditis, collagen diseases, rheumatic fever, thrombotic thrombocytopenic purpura, amyloid and hereditary medial necrosis associated with certain neurological disorders such as Friedreich's ataxia and progressive muscular dystrophy.

# SUMMARY

There are a number of potential sources of error in the interpretation of coronary arteriograms. These may occur as a result of superimposition of other arteries upon the left anterior descending artery, nondominance of the right coronary artery, variations in the distribution of the posterior descending artery, myocardial bridging, recanalization of arterial thrombi, and small vessel obstruction. These situations may contribute significantly to previously reported high rates of inaccuracy in the interpretation of coronary arteriograms.

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# EPICARDIAL FAT LINE IN LEFT PLEURAL EFFUSION

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ROENTGENOLOGIC visualization of the epicardial fat line demonstrating the heart within 2 millimeters of the cardiac silhouette is generally accepted evidence of pericardial effusion or thickening.<sup>1–3</sup> The epicardial fat line is located in a layer of fibroconnective tissue between the visceral pericardium and myocardial muscle mass. It is concentrated mainly along the course of the coronary arteries in the atrioventricular grooves and along the inferior portion of the left ventricle.<sup>1–3</sup>

In 1955, Kremens<sup>2</sup> was the first to use both routine roentgenograms and tomograms to call attention to the visualization of the myocardial mass within the cardiac silhouette due to the presence of a subepicardial fat layer. He noted this in both normal subjects and pathologic conditions having either thickened pericardium or pericardial effusion. Torrance,3 a few months later, also noted the same phenomenon in patients and in a water phantom. One major drawback to seeing this line was cardiac motion. Jorgens et al., however, took advantage of this motion using cinefluoroscopy in studying the pulsating outlines about the heart in diagnosis of pericardial effusion.

Surprisingly, no attention has been given in the literature to the demonstration of the epicardial fat line in the presence of pleural effusion.

It is the purpose of this communication to stress that attention to this roentgenologic sign may aid in the demonstration of the cardiac contour in spite of large fluid collections in the left pleural cavity.

## RESULTS

We have recently observed 10 cases dem-

onstrating this finding. Exposures were in the 100 kilovoltage range, utilizing either a stationary or moving grid. Employing a lower (70) or higher (120) kilovoltage did not significantly lead to image enhance-



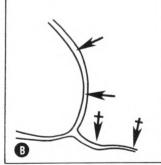


Fig. 1. (A and B) Tomogram of a 64 year old female with metastatic carcinoma of the cervix demonstrating a large left pleural effusion and epicardial fat line indicated by arrows ( $\uparrow$ ). Also note the left hemidiaphragm outlined by its extraperitoneal fat layer ( $\uparrow$ ).

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Case	Age	Sex	Clinical Diagnosis
ı. AG	I. AG 64		Metastatic squamous cell carcinoma (Fig. 1, $A$ and $B$
2. MA	52	F	Metastatic lung carcinoma
3. EJ	84	F	Metastatic breast carcinoma
4. CF	67	F	Metastatic breast carcinoma
5. HC	68	M	Chronic congestive heart failure (Fig. 2, A and B)
6. DC	64	M	Chronic congestive heart failure, cardiomyopathy
7. EB	45	F	Chronic renal failure
8. JB	59	F	Renal failure, pulmonary emboli
9. WR	52	M	Postoperative coronary artery bypass graft
10. RP	78	M	Pneumonia, empyema (Fig. 3, $A$ and $B$ )

ment. However, overpenetrated films, as well as tomograms, improved visualization of the fat line in several cases. These latter 2 methods are recommended for questionable cases and might be attempted even though the fat line is not seen on routine roentgenograms.

Table I gives a summary of the 10 cases. As can be seen, the causes of the effusions were various. Four effusions were due to metastatic carcinoma (Fig. I, A and B), and 4 secondary to chronic fluid overload. Two were found in association with chronic congestive heart failure and 2 in association

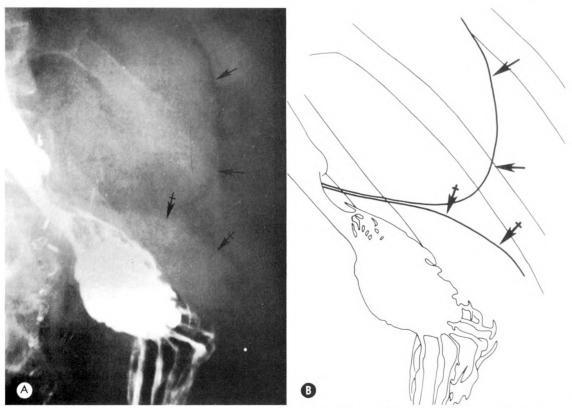
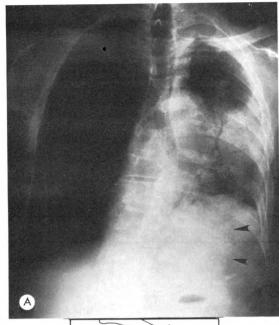


Fig. 2. (A and B) Spot roentgenogram taken at fluoroscopy of a 68 year old male in chronic congestive heart failure showing left pleural effusion and epicardial fat line ( $\uparrow$ ) demonstrating cardiomegaly. Left hemidiaphragm position again indicated by its fat line ( $\uparrow$ ).



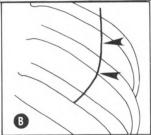


Fig. 3. (A and B) Plain roentgenogram of a 78 year old male with pneumonia and empyema. Notice shift of heart to left secondary to pulmonary volume loss as indicated by epicardial fat line (A).

with renal failure (Fig. 2, A and B). One occurred postoperatively following thoracotomy and I was associated with pneumonia and empyema (Fig. 3, A and B). Not only are the cardiac size and position well demonstrated, but in several of our cases the position of the diaphragm is visible because of a layer of extraperitoneal fat on its undersurface<sup>4</sup> (Fig. I; and 2).

#### DISCUSSION

Demonstration of the epicardial fat layer in pleural effusions is of significance in several respects. First, it enables one to determine cardiac size when the left cardiac margin is obscured by a large pleural effusion. Heart size is important in determining the etiology of the fluid. In states of fluid imbalance such as cardiac or renal failure, the heart would be expected to be increased in size, whereas in many other conditions leading to effusion cardiac size would be expected to be normal. Furthermore, cardiac and diaphragmatic positions are important in determining the presence or absence of an associated pulmonary volume loss.

#### SUMMARY

Determination of cardiac size, cardiac displacement or both in association with left pleural effusion can be accomplished with the aid of the epicardial fat line.

As this is visible probably rather commonly, radiologists should be aware of this phenomenon as a valuable method in the differential diagnosis and over-all clinical assessment and management of patients.

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# FURTHER OBSERVATIONS ON THE LUNG PATCH TECHNIQUE\*

# WITH ANALYSIS OF THE FIRST 50 CASES

By RONALD L. McCARTNEY, M.D. LOMA LINDA, CALIFORNIA

THE initial description of our technique of lung patch following percutaneous pulmonary biopsy of necessity contained considerable detail of the preliminary animal work. When this work was first presented, 25 patients had been biopsied with the patch technique without immediate pneumothorax or other complications. An additional 25 cases are now reported, and the group of 50 cases is analyzed in detail (Table 1). Some pertinent clinical observations not previously appreciated are presented.

#### MATERIAL

Most of the patients referred for percutaneous pulmonary biopsy fall into 5 categories:

- 1. Patients with obvious chest lesions, probably primary malignancies, with negative work-up (bronchoscopy, bronchial washings, sputum cytology, mediastinoscopy etc.). Most of these would be candidates for radiotherapy; some are surgical candidates.
- 2. Patients with obvious pulmonary metastasis of unknown origin in whom work-ups fail to identify the site of origin.
- 3. Patients with multiple known primaries in whom the tissue diagnosis is the determining factor in selecting a chemotherapeutic regimen.
- 4. Patients with apparently arrested or cured malignancy who years later are found to have pulmonary nodules.
- 5. A mixed group with slowly resolving pneumonic-type infiltrates or pulmonary abnormalities thought to be acutely inflammatory. Precise diagnosis in this latter group is elusive, and initial medical treatment has failed.

#### RESULTS

Table I presents the findings on the first 50 blood patched lung biopsy cases for which complete records were available. No significant hemoptysis, pneumothorax, nor pulmonary hemorrhage occurred. Three patients produced a small amount of bloodinged sputum in the first few hours after biopsy. Four patients had significant pneumothoraces, 2 complete and 2 large enough to produce some respiratory distress. Chest tubes were placed in 3, and I was operated for removal of the biopsicd nodule the day of the collapse.

An immediate complete pneumothorax occurred following needle passage anteriorly through an upper lobe bulla to a lesion not easily reached from a posterior approach because of the interposed scapula (C.A.). A second complete pneumothorax resulted from needle violation of the pleura distal to a lesion (C.R.). A large pneumothorax requiring a tube occurred after the biopsy needle crossed the major fissure distal to the biopsied nodule (S.M.). The fourth large pneumothorax resulted from the biopsy needle crossing the minor fissure (D.C.). This last patient had no immediate pneumothorax, but a marginal one was present the second day and a large one was seen on the third day. Surgery on the third day for removal of the nodule revealed a competent blood patch proximal to the lesion. Distal to the lesion, the biopsy needle had crossed the upper lobe pleura adjoining the minor fissure and entered the middle lobe. This case confirmed our suspicion that violations of the pleura distal to the blood patch were responsible for the pneumothoraces we had been seeing and also accounted for the larger number of

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Table I
ANALYSIS OF 50 CASES

	A ~~			D' . 1 Di		edure	A AND COMMITTEE TO THE COMMITTE	
Patient	Age and Sex	Lesion Location	Ap- proach	Distal Pleura or Fissure Crossed	Im- medi- ate	De- layed	Treat- ment	Comment
M.P.	45 Q	LLL	Post	}	No	No	None	
S.W. #1	65 ð	RLL	Ant	No	No	No	None	Repeated
S.W. #2	65 d	LUL	Post	No	No	No	None	
A.H.	68 P	RUL	Post	No	No	No	None	
S.M.	70 P	RUL	Post	No	No	No	None	
M.G.	64 ₽	RML	Post	Poss. Major F	No	No	None	
C.B.	59 ♂	LUL	Ant	No	No	No	None	
J.B.	45 ♀	Diffuse	Post	No	No	No	None	•
R.S.	52♂	LUL	Ant	No	No	No	None	
E.P.	678	LUL	Post	}	No	No	None	
A.D.	68 ₽	RLL	Lat	No	Yes	No	None	Marginal—produced by Anes. needle
J.D. #1	59 o <sup>r</sup>	LUL	Ant	No	No	No	None	Repeated
J.D. #2	59 ♂	LUL	Ant	No	No	No	None	
P.B.	73 ♂	RLL	Post	Yes	Yes	Yes	None	Marginal
S.C.	78 ₽	RUL	Ant	?	No	No	None	
I.W.	67 ♀	LLL	Ant	Prob	Yes	No	None	Marginal
W.G.	70 d	RML ·	Ant	Yes	Yes	No	None	Marginal—crossed minor fissure
L.B. #1	53♂	LLL	Lat	No	No	No	None	Repeated
L.B. #2	53 ♂	LLL	Lat	No	No	$N_0$	None	
J.S.	<b>5</b> 7 ₽	RLL	Post	No	No	No	None	
R.W.	29♂	LUL	Post	Yes	$N_0$	$N_0$	None	
O.S.	66 ₽	LUL	Post	No	No	No	None	
C.R.	70 ð	LUL	Ant	Yes	Yes	Yes	Chest tube	Violated posterior pleura
E.S.	62 ♂	RUL	Post	Yes	No	Yes	None	Middle lobe only collapsed
M.B.	630	RUL	Post	No	No	No	None	
M.B.	63 8	RUL	Ant	No	No	$N_{o}$	None	2nd biopsy
D.D.	64♂	RUL	Post	No	No	Yes	None	Marginal
T.M.	69 ♂	RML	Post	No	No	No	None	
R.I.	63 P	RLL	Ant	No ·	No	No	None	** ** ** ** **
C.A.	58♂	LUL	Ant	Yes	Yes	No	Chest tube	Needle through bulla, complete
D.A.	61 b	RUL	Post	Yes	No	Yes	None	Marginal
E.O.	69 o	LLL	Ant	Yes	No	Yes	None	Marginal
E.I.	78 ₽	RLL	Ant	No	No	No	None	<b>a</b>
S.M.	53 ♀	LUL	Post	Yes	Yes	Yes	Chest tube	Complete
M.I.	81 Q	RLL	Post	No	No	No	None	•
A.U.	48 ♀	LLL	Ant	No	No	No	None	
I.M.	64 ₽	RLL	Ant	Poss	No	No N-	None	
L.H.	62 o <sup>7</sup>	RUL	Post.	No No	No	No No	None	
L.G. S.C.	58 c <sup>7</sup>	RLL	Ant	No Poss	No	No No	None	
T.S.	71♂ 42♂	RLL LUL	Ant Post	Poss No	No No	No No	None None	
D.C.*	300	RUL	Ant	Yes	No	Yes	Thora- cotomy	Nodule removed, large pneumo. needle, puncture distal to patch
S.G.* D.H.*	54 Չ 36 Չ	RUL RLL	Post Post	Yes No	No No	No No	None None	

<sup>\*</sup> Three later cases are added.

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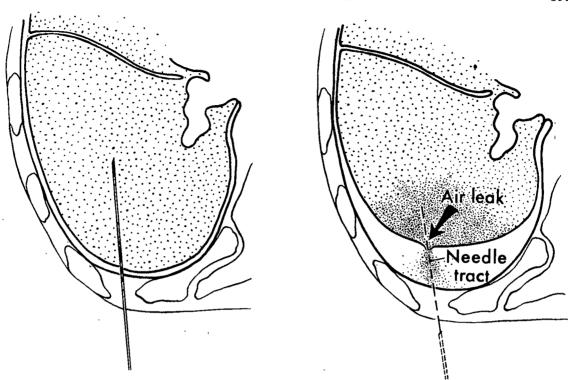


Fig. 1. The usual mechanism for producing iatrogenic pneumothorax: a hole in the visceral pleura.

delayed pneumothoraces as compared with the immediate. Of the 13 pneumothoraces, only these 4 were significant; the 9 marginal cases, either immediate or delayed, produced no symptoms and quickly resolved spontaneously.

# DISCUSSION

It will be noted that the significant failures resulted from obvious technical errors and that most of the marginal pneumothoraces could be attributed to pleural violations distal to the blood patch and the biopsied lung area. Prior to the use of lung patch, our experience had been that pneumothorax occurred immediately or within the first hour after the procedure, if it occurred. Only occasionally did we see a delayed onset pneumothorax. In the last 50 cases, however, that impression has been reversed. Analysis of our material has pointed to lung fissures as a source of air leak.

Figure 1 shows the mechanism for the

usual iatrogenic pneumothorax, the needle hole in the visceral pleura. The usual postbiopsy pneumothorax is produced in this way. Figure 2 shows how the blood patch prevents the usual type pneumothorax. To explain pneumothorax occurring after blood patch use required us to postulate two mechanisms: (1) blood patch failure due to resorption, clot lysis, etc.; or (2) some air leak other than the one patched. Our animal work which demonstrated persistence of the patch for at least I week showed the first option to be very unlikely.

# ANALYSIS OF THE FAILED CASES

Analysis of the failed cases revealed the following 4 ways that failure can occur (Table II):

(1) One of the most obvious ways of producing pneumothorax is using indiscriminate anesthesia of the chest wall. We have avoided this by using a  $\frac{5}{8}$  inch No. 25 Ga needle for superficial anesthesia and the Jelco patch needle for deeper anesthesia,

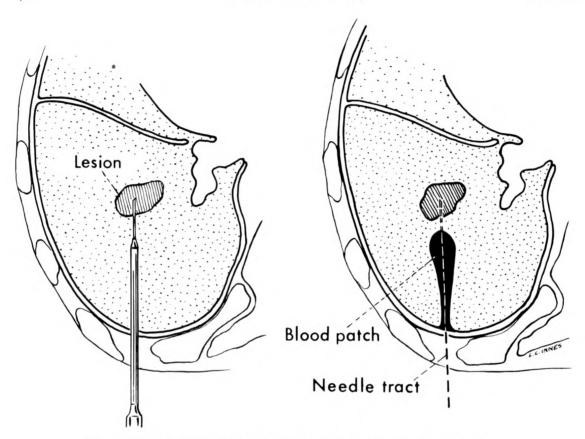


Fig. 2. The hole in the visceral pleura may be sealed by injecting autogenous blood into the needle tract, preventing pneumothorax.

the infiltration continuing until the tip is advanced across the pleural space and into the lung. However, I patient in this series had a chest wall so thin that the  $\frac{5}{8}$  inch needle reached the visceral pleura, and a marginal pneumothorax resulted before the Ielco needle was inserted.

(2) Another obvious failure occurred when an anterolaterally-placed lesion was approached anteriorly through an intervening bulla. The posterior approach was declined because of difficulty in circumventing the scapula. An immediate collapse ensued as the Jelco needle was inserted into the bulla. In this case, the lung retracted from the Jelco needle so that a blood patch could not be applied. Even if we had been able to apply a patch, it is unlikely that it would have been effective, for pulmonary parenchyma or other tissue is needed to hold the blood patch (Fig. 3).

(3-4) The majority of the failures were found to be related to Error 3, violations of a fissure distal to the lesion, or, in one case, Error 4, inadvertent advancement of the needle to the opposite pleural surface. Both of these types of mistake occur easily when the lesion is adjacent to a fissure, either proximally or distally, or when the lesion is close to the visceral pleura opposite the entry site (Fig. 4; and 5). We can seal the needle entry but not the pleural opening distal to the lesion. Review of the case failures confirmed the close proximity of the lesion to a fissure or the distal pleura. The complete pneumothorax occurring on the third day after biopsy came to thoracotomy for removal of the biopsied lesion the day of the collapse. At thoracotomy, it was seen that the biopsied lesion was on the anterior inferior aspect of the upper lobe adjacent to the minor fissure. The entry wound was

Table II summary of the 6 failed cases

A				D' (ID)	Procedure			•	
	Ap- proach	Distal Pleura or Fissure Crossed	Im- medi- ate	De- layed	Treat- ment	Comment			
V.F.	56 Q	RLL	Post	Yes	No	Yes	None	Marginal	
E.G.	43 <sup>Q</sup>	RUL	Post	No	No	No .	None	Marginal pneumothorax 5 days post treatment	
J.K.	49 o <sup>71</sup>	RUL	Post	No	No	No	None	3 , . 1	
J.M.	79 o <sup>3</sup>	RUL	Post	No	No	No	None .		
O.D.	55 o	RLL	Post	No	No	No	None		
E.P.	56♂	RLL	Post	No	No	No	None		

Marginal = <10%. Complete = >75%

identified, with the blood patch beneath it very effectively sealing the proximal needle tract. At least one site was obvious on the inferior aspect of the fissure, where the biopsy needle had crossed the fissure into the middle lobe, leaving an unsealed air leak. What then would cause the delayed collapse? We believe the pleural surface opposing the unsealed opening acts as a flap valve, partly covering the opening

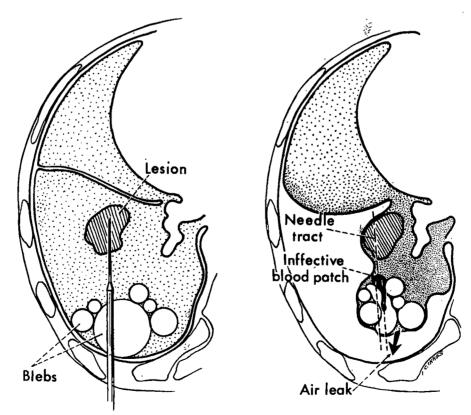


Fig. 3. Needle insertions through blebs cannot be successfully patched because tissue is insufficient to hold the clotted blood.

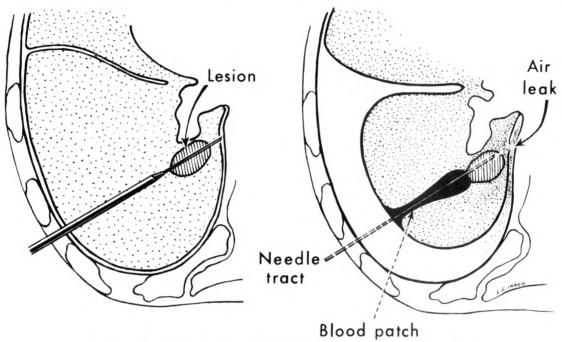


Fig. 4. Needle insertion through distal visceral pleura cannot be patched; pneumothorax results even with effective proximal patch.

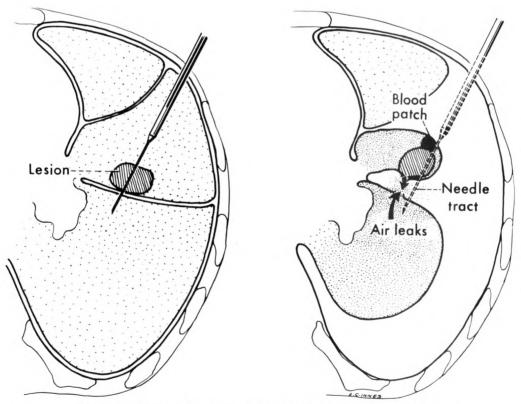


Fig. 5. Needle insertion across fissures distal to lesion cannot be patched; pneumothorax results despite effective proximal patch.

and preventing an immediate collapse as we had come to expect from holes in the visceral pleura. The negative intrapleural pressures are probably higher and more prolonged on the peripheral visceral surface than in the fissures. In the latter location, the expanding lung opposite the opening must partially seal it so that collapse is slower than if the opening was opposite the chest wall.

#### CONCLUSION

The result of these observations is that we now consider the location of the lesion in relation to the fissures as important a consideration as the chest wall and other factors when planning the needle approach. We believe that this additional detail will make pneumothorax a completely avoidable complication.

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# A COMPARISON OF AN AIR GAP AND A GRID IN ROENTGENOGRAPHY OF THE CHEST\*

By E. DALE TROUT, B.S., D.Sc., JOHN P. KELLEY, B.S., and VAUGHN L. LARSON, B.S. CORVALLIS, OREGON

THE use of an air gap versus a grid finds its way into any discussion of roentgenographic' technique for the chest. In evaluation of the facilities being used in the coal miners' pneumoconiosis study we have noted the fact that an air gap technique is, in some cases, being used. Of the 262 facilities submitting roentgenograms in the pneumoconiosis program under Public Law 91-173, 6 facilities have indicated that they are using an air gap technique. Of the 6 facilities, I is using a 5 inch air gap, I a 6 inch air gap, I a 7 inch air gap, and 3 are using an 8 inch air gap. One of the 6 facilities is using a 6 foot focal-film distance, I is using 7 feet, 3 are using 8 feet and 1 is using 10 feet. It will be noted that there is little uniformity in the air gap space and the focal-film distance.

In spite of the fact that such techniques are being used, there seems to be no definitive reference as to the variables that may be employed and their influence on the resulting roentgenogram. We reviewed 10 references of which only I treated the subject in depth. Most of the references covered the subject in a single sentence or in a single short paragraph. Nowhere did we find any extensive description of all of the variables and results brought about by changes in these variables.

Not many of the references had anything to say about the mechanism which results in increased contrast when an air gap is used. The increased contrast that occurs in the use of an air gap is the result of decreased scattered radiation reaching the film plane. This, as we see it, is due to 2 processes. A small part is due to the fact that the scattered radiation coming off at

an acute angle to the incident beam may

miss the film entirely as the film is moved away from the scattering object, i.e., the patient. The major effect is due to the fact that the scatter source is the patient and the scattered component of the useful beam which reaches the film is reduced by absorption within the patient and by the rapid reduction of scattered intensity due to the inverse square-law. The useful beam source is several feet from the film and as the film is moved away from the patient the reduction in intensity of the useful beam is not very great. The point at which scattered radiation is produced is within the patient and as the film is moved away from the patient the intensity of the scattered radiation falls very rapidly due to the inverse square law. This is a very complex situation wherein scattered radiation originating in the posterior portion of the chest will be attenuated by a great deal of tissue. Scattered radiation originating at the midplane of the patient is subject to less attenuation by the tissue, but by increased loss of intensity due to the inverse square law. Scattered radiation produced in the portion of the chest near the film will be reduced very little by attenuation in the tissue but will be reduced most rapidly by the inverse square law as the film is moved away from the patient.

In a previous presentation before this Society, we described a test phantom being used in the pneumoconiosis program, and the use of this test object enables us to study some of these variables and to assign some relative significance to them.

About 75 per cent of the approved facilities involved in the pneumoconiosis program are using grids with ratios of 6:1, 8:1 and 10:1. A few are using 12:1 grids.

<sup>\*</sup> Presented at the Seventy-fifth Annual Meeting of the American Roentgen Ray Society, San Francisco, California, September 24-27, 1974.
From the X-Ray Science and Engineering Laboratory, Oregon State University, Corvallis, Oregon.

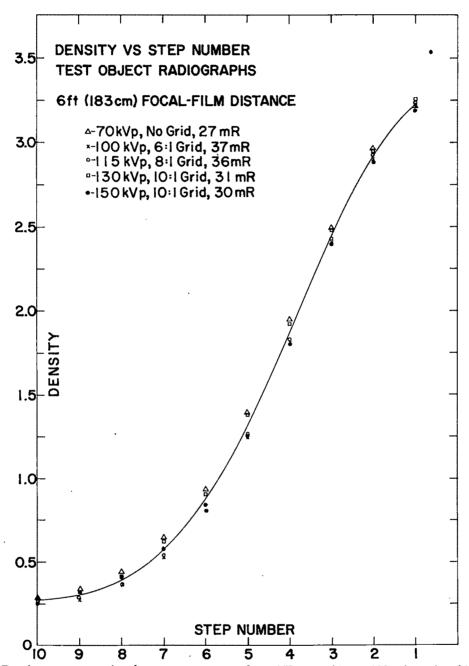


Fig. 1. Density vs. step number for constant contrast for 70 kVp, no grid; 100 kVp, 6.1 ratio grid; 115 kVp, 8:1 ratio grid; and 130 kVp, 10:1 ratio grid. Also shown are data points for 150 kVp with 10:1 ratio grid.

About 74 per cent of the grids used are of the 103 lines per inch type. The general tendency is to increase the kilovoltage as higher grid ratios are used. In our previous paper we demonstrated the kilovoltage that

techniques using no grid and 103 line grids of 6:1, 8:1 and 10:1 ratio. Some users of the high ratio grids are employing energies as high as 150 kVp. In Figure 1, we have plotted density of the various steps of the would maintain a constant contrast for test phantom under conditions that pro-

#### GEOMETRY OF EXPERMENTAL SETUP

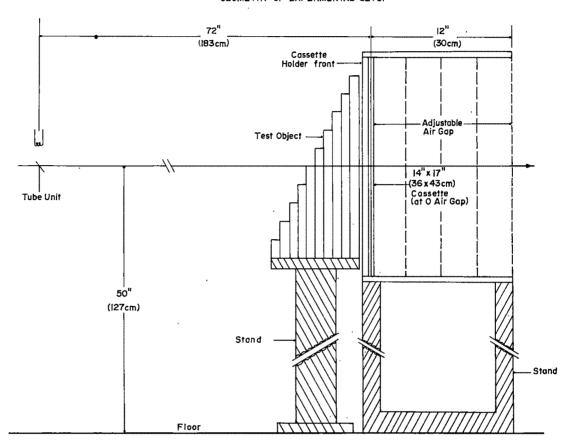


Fig. 2. Geometry of experimental set-up.

vide the same contrast along with values for 150 kVp with a 10:1 grid. We thought it would be of interest to look at the relative contrast provided by grid techniques and air gap techniques along with the relative incident exposure to the patient.

# EQUIPMENT

Details of experimental set-up used are shown in Figure 2.

Of the approved facilities in the pneumoconiosis program, 86 per cent are using single-phase equipment. Accordingly, the x-ray source used in our study was a single-phase, 2 pulse unit. Spot checks made with a 3 phase, 12 pulse unit indicated that the results would have been similar, although, as would be expected at any given kilovoltage, the contrast was slightly lower

with the 3 phase equipment. For all our work we used medium speed film and medium speed intensifying screens since these are called for under regulations set up for the National Institute for Occupational Safety and Health pneumoconiosis program.

#### EXPERIMENTAL DATA

Figure 3 shows the density for the steps of the test object using 100 kVp, a 6 foot focal-film distance with no grid, a 6:1 ratio, 103 line grid and air gap spaces up to 12 inches. As one increases the kilovoltage with higher grid ratios the contrast remains essentially constant when 8:1 grids are used at 115 kVp and 10:1 grids at 130 kVp. When 150 kVp is used with a 10:1 grid, the contrast is slightly less than that obtained

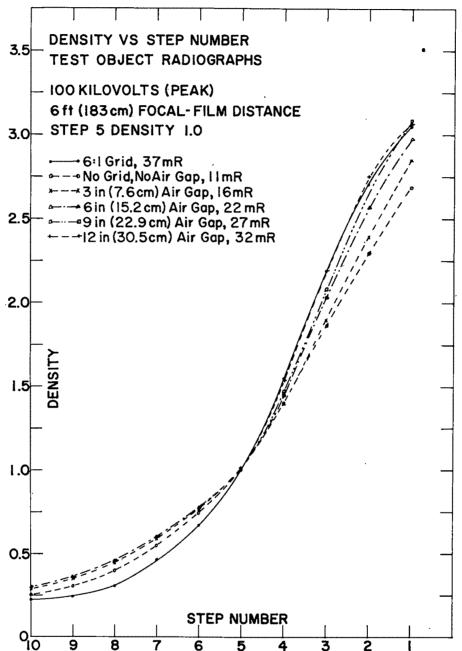


Fig. 3. Density vs. step number; 100 kVp, 6 ft. focal-film distance with 6:1 grid, no grid or air gap, and air gaps of 3, 6, 9 and 12 inches.

under the foregoing conditions, and associated with the reduced contrast is a slight increase in latitude. Generally, it can be said that comparable contrast can be had with air gaps in the higher density ranges, i.e., for the higher density portions of the

roentgenogram. With thicker sections, i.e., lower roentgenographic densities, the contrast is not quite so great when an air gap technique is used. In general it can be said that comparable contrast can be obtained with both grids and air gaps.

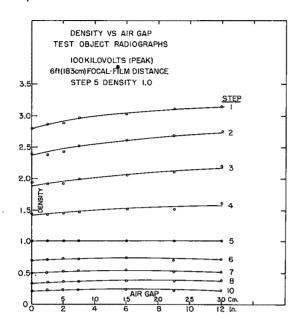


Fig. 4. Density vs. air gap space, 6 ft. focal-film distance.

If the density for various steps is plotted against the air gap space when a density of 1.0 is maintained for step 5, as shown in Figure 4, it will be seen that the density changes very little in the thicker steps, but in the thinner steps, i.e., where higher roentgenographic densities are obtained, there is an increasing difference in contrast as the air gap space is increased from 0 to 6 inches. Beyond 6 inches there is a much smaller increase in contrast as the air gap space is increased. This leads to the conclusion that an air gap of 6 inches can be justified but there is a decreasing improvement in contrast for air gaps greater than 6 inches.

To further study the effect of changing the air gap space, measurements were taken using a 10 foot distance to the face of the film holder. A thin wall ionization chamber was moved away from the face of the film holder behind step 5 of the test object. The decrease in intensity that would have been expected due to the inverse square law is plotted as the dashed line in Figure 5. The actual measured values when using 100 to 150 kVp are shown by the solid line. It will be seen that as the air gap space is increased

the measured value falls much more rapidly than the calculated rate. It will also be seen that the beam intensity falls rapidly until a 6 inch air gap space is obtained and has a tendency to reach a plateau for air gap spaces greater than 6 inches. This indicates that contrast increases quite rapidly in the first 6 inches of air gap space.

#### CONTRAST

If the roentgenographic density is plotted against the thickness of the scattering medium, in this case the steps of the test object, one can extend the straight line portion of such a curve to the base line. The angle between this line and the base line can be used as a measure of contrast by taking the tangent of this angle. The result of such a determination for various air gap spaces and various grid ratios is shown in Table 1. The larger the number is, the greater the contrast. It will be seen, for example, that at 100 kVp the tangent for this angle using neither an air gap nor a grid is 0.88. Using a 6 inch air gap the contrast is 1.12. A 9 inch air gap gives a contrast of 1.19, and a 12 inch air gap 1.27. Using 100 kVp with the grids yields a contrast of 1.24 for the 6:1 grid, 1.28 for the

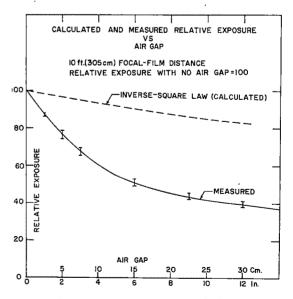


Fig. 5. Calculated and measured relative exposure vs. air gap space, 10 ft. focal-film distance.

Table I

RELATIVE CONTRAST\*

AIR GAPS AND GRIDS

6 ft. (183 cm.) Focal-film Distance

		Air Gap-	-Inches (Ce	ntimeters)		Grid Ratio		
kVp o(o)	3(7.6)	6(15.2)	9(22.9) Relative Co	12(30.5) ntrast	6:1	8:1	10:1	
70	1.10	NAMES	_			A	_	
100	0.88	0.98	1.12	1.19	1.27	1.24	1.28	1.32
115	0.83	0.95	1.07	1.16	1.23	1.20	1.25	1.30
130	0.78	0.92	1.03	1.13	1.19	1.18	1.23	1.27
150	0.76	0.88	0.99	1.07	1.13	1.11	1.14	1.17

<sup>\*</sup> Slope (tangent) of straight line portion of density vs. test object step number.

8:1 grid and 1.32 for the 10:1 grid. In actual practice the kilovoltage is usually increased as the grid ratio is increased, and at 115 kVp the contrast is 1.25 for an 8:1 grid and at 130 kVp the contrast for a 10:1 ratio grid is 1.27. If a value of 150 kVp is used with a 10:1 ratio grid the contrast is reduced to 1.17. If 100 kVp is used with a 6 inch air gap space the resulting contrast is 1.12 which is not so great as would be obtained with grids at lower kilovoltages, but not greatly different from the contrast obtained at 150 kVp with the grids.

#### MAGNIFICATION

As the air gap space is increased the

images on the roentgenogram are magnified depending on the focal-film distance used and the depth of the image forming structure in the chest. This results in a roentgenographic image that is not so sharp as that obtained without any air gap between the patient and the film. The use of an air gap with a 6 foot focal-film distance results in images less sharp than those obtained with no air gap. Magnification of images in the posterior portion of the chest will be greater than those in the anterior portion of the chest due to differences in part-film distance. As the focal-film distance is increased the magnification decreases. In Table II are shown the magnification fac-

Table II

AIR GAP AND FOCAL-FILM DISTANCE US. MAGNIFICATION CALCULATED
FOR IMAGE AT MID-PLANE OF 22 CM. CHEST

	Focal-film Distance							
Air Gap	6 ft. (183 cm.)	8 ft. (244 cm.) Magn	10 ft. (305 cm.) ification	12 ft. (366 cm.)	14 ft. (427 cm.)			
0	1.09	1.07	1.05	1.04	1.04			
6 in. (15.2) cm.)	1.20	1.14	1.11	1.09	1.08			
7 in. (17.8 cm.)	1.22	1.16	1.12	1.10	1.08			
8 in. (20.3 cm.)	I.24	1.17	1.13	1.11	1.09			
9 in. (22.9 cm.)	1.26	1.19	1.14	1.12	1.10			
o in. (25.4 cm.)	1.29	1.20	1.15	1.13	1.11			
1 in. (27.9 cm.)	1.31	1.22	1.17	1.13	1.11			
2 in. (30.2 cm.)	1.33	1.23	1.18	1.14	1.12			

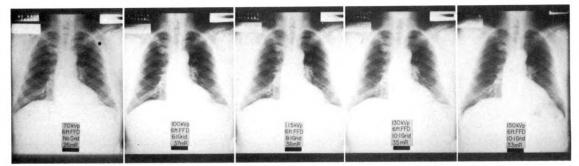


Fig. 6. Chest roentgenograms at 6 ft. focal-film distance, no air gap; 70 kVp, no grid; 100 kVp, 6:1 grid: 115 kVp, 8:1 grid: 130 kVp, 10:1 grid: 150 kVp, 10:1 grid.

tors for images produced by a structure at the midplane of a 22 cm. chest. It will be seen that using a 6 foot no air gap technique, the magnification factor is 1.09. If the 6 foot focal-film distance is retained and a 6 inch air gap is used the magnification factor will be 1.20 or a little more than twice that for roentgenography without an air gap. If a 10 foot focal-film distance is used with a 6 inch air gap the magnification factor will be 1.11, not greatly different from the image obtained with no air gap 6 foot techniques.

A series of roentgenograms of a 26 cm. patient was made at a 6 foot focal-film distance using no grid or air gap and grids of 6:1, 8:1 and 10:1 ratio. A second series of roentgenograms was made at a 10 foot focal-film distance with an air gap of 6 inches. These are shown in Figures 6 and 7.

# PATIENT EXPOSURE

Any comparative study of roentgenographic techniques must take into consideration the incident exposure to the patient. In Table III are shown the incident exposures in our laboratory for the various techniques described. The exposures were measured in air for roentgenograms of the 26 cm. patient. For comparison it may be noted that the exposure using 100 kVp, a 10 foot focal-film distance and a 6 inch air gap is equal to the exposure at 70 kVp, a 6 foot focal-film distance with no grid and no air gap. By referring to Table I it will be seen that the contrast is about the same for the 2 techniques.

#### CONCLUSIONS

- 1. As a result of our study we feel that air gap techniques are very useful and can provide contrasts equal to those obtained with grids.
- 2. An air gap technique using a 10 foot focal-film distance and a 6 inch air gap would seem to be a good compromise.
- 3. Patient exposure with an air gap (in spite of the increased focal-skin distance) is comparable to a no grid, no air gap technique and is less than that obtained for



Fig. 7. Chest roentgenograms at 6 ft. focal-film distance, no air gap; 70 kVp, no grid or air gap; 10 ft. focal-film distance with 6 inch air gap at 100, 115, 130 and 150 kVp.

Table III

PATIENT EXPOSURE IN AIR FOR POSTEROANTERIOR CHEST ROENTGENOGRAMS

Patient Thickness 26 cm. 103 Line Grids

kVp	Focal-film Distance	Grid	Air Gap	Exposure mR
70	6 ft. (183 cm.)	None	None	26
100	6 ft. (183 cm.)	6:1	None	. 37
100	10 ft. (305 cm.)	None	6 in. (15.2 cm.)	26
115	6 ft. (183 cm.)	8:1	None	36
115	10 ft. (305 cm.)	None	6 in. (15.2 cm.)	25
130	6 ft. (183 cm.)	10:1	None	35
130	10 ft. (305 dm.)	None	6 in. (15.2 cm.)	22
150	6 ft. (183 cm.)	IO:I	None	33
150	10 ft. (350 cm.)	None	6 in. (15.2 cm.)	19

techniques using grids.

- 4. The use of an air gap instead of a grid requires less precise centering than is the case for grids where lateral centering must be quite good, especially for the higher ratio grids.
- 5. The major disadvantage with the air gap technique is the additional space required by the use of a longer focal-film distance. We made some measurements and came to the conclusion that a room providing a distance of 11½ feet is required when a simple film holder is used on the wall with a 10 foot focal-film distance. In making this determination provision was made for a distance of 1 foot for draping the high voltage cables from the ceiling to the tube.

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# CONTACTS OF THE LEFT LUNG WITH THE MEDIASTINUM

## SOURCES OF DIAGNOSTIC ERROR

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KNOWLEDGE of gross anatomy leads to knowledge of roentgen anatomy, which in turn leads to detection of roentgen abnormality. A break in this chain can lead to serious error.

The following terms for describing the roentgen anatomy of the mediastinum are suggested: *line* implies a roentgenologic contrast pattern of length with minimally detectable width; *stripe* implies greater width, but length still dominates the pattern; *interface* implies 2 areas of differing densities abutting on each other but neither dimension dominating.

These contacts of the left lung with the mediastinum and their roentgenologic counterparts on frontal studies have been described<sup>5</sup>:

- 1. Posterior mediastinal line: approximation of left and right lung with intervening mediastinum, posterior to the esophagus and above the aortic arch;
- 2. Inferior posterior mediastinal line: continuation of the same line below the aortic arch;
- 3. Anterior mediastinal line: approximation of left and right lung with intervening mediastinum anterior to the heart;
- 4. Left pleuroesophageal stripe: contact of left lung with the left wall of the esophagus above and below the aortic arch;
- 5. Left paraspinal interface: contact of left lung with the left paraspinal soft tissues;
- 6. Left aortic interface: contact of left lung with the aortic arch (the roentgenologic "knuckle") and with the descending thoracic aorta;
- 7. Left subclavian artery interface (at its origin and proximal portion) with the left lung, and left subclavian artery stripe (when the cephalic and caudal borders of

the subclavian artery are visualized by contrasting lung as the artery pursues its course anterior to the apex on its way to the tubercle of the first rib);

8. Interface between left lung and the left common carotid artery, and between left lung and an anomalously arising right subclavian artery.<sup>3</sup> The identification of these structures can be suspected but requires arteriography. These structures make *interfaces* rather than *stripes* because their medial contours are not delineated by lung (Fig. 1).

Two other contacts of the left lung with the mediastinum, not to be confused with abnormal tissue, may be seen in the medial aspect of the left pulmonary apex: (1) left paraspinal interface occasionally can be followed from its better known position be-

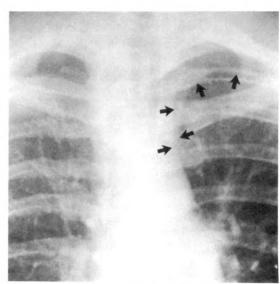


Fig. 1. Lateral-most 3 arrows indicate the left subclavian artery in its course across the apex to the tubercle of the first rib. Medial-most 2 arrows indicate most likely the left common carotid artery, but confirmation would require angiography.

low the aortic arch, transsecting the aortic "knuckle," and merging into the medial soft parts of the apex (Fig. 2); (2) mediastinal left lung interface anterior to the pulmonary artery commonly presents as a sharp or poorly defined roentgenologic interface, and may continue cephalad to transsect part or all of the aortic "knuckle," merging into the medial soft parts of the apex (Fig. 3). When the radiologist becomes accustomed to identifying these interfaces in the medial soft tissue of the left apex with their anatomic substrates, any departure from normal of contour or density of the left paratracheal supra-aortic soft tissues at once becomes salient, and he runs less risk of missing early disease.

In an effort to define the criteria for detecting malignant mediastinal lymph nodes, Blank and Castellino<sup>2</sup> investigated the normal roentgenologic patterns of the interface of the left lung with the left mediastinum anterior to the pulmonary artery and aortic "knuckle." Identification of subtle changes from malignant lymph

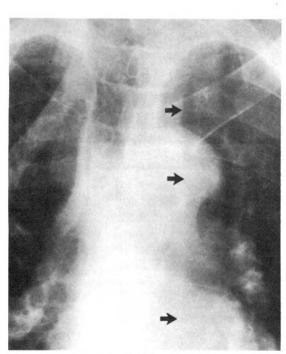


Fig. 2. The left paraspinal interface is demonstrated transsecting the aortic "knuckle," continuous with its better known position below the aortic arch.

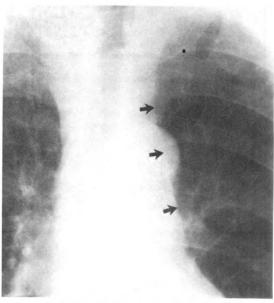


Fig. 3. Mediastinal left lung interface anterior to the pulmonary artery continues cephalad, transsects the aortic "knuckle," and merges into the medial soft parts of the apex.

nodes may require serial study. This interface falls into several major roentgenologic patterns which may vary according to the direction of the central ray and to the de-

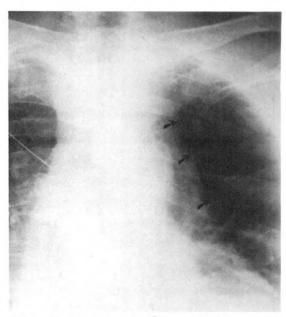
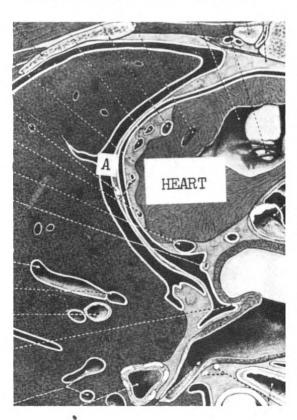


Fig. 4. Bedside anteroposterior study demonstrates a soft tissue interface (arrows) well to left of aortic arch, suggesting abnormal mediastinum in this patient with severe back pain.



Fig. 5. Teleroentgenogram done 2 weeks after Figure 4 and during convalescence demonstrates the interface (arrows) in a more customary location. A supine anteroposterior study done at the same time for comparison with the previous study shows findings identical to those of Figure 4. A recent change in the mediastinum is thus excluded.



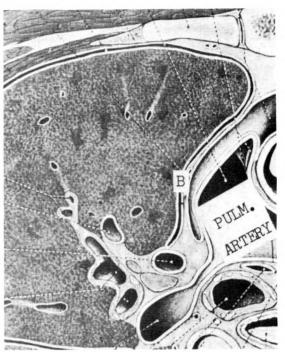


Fig. 7. "B" is continuous with "A" of Figure 6, and casts a sharp roentgenologic interface in those subjects in whom it is parallel to the incident ray. "B" corresponds to the lower-most arrow in Figure 5.

gree of inspiration, and which are determined by the pattern of "perpendicularity" to the incident ray: (1) no detectable interface, when the anatomic interface is not sufficiently parallel to the incident ray to cast a roentgenologic shadow; (2) an interface with a left lateral bulge confined to the level of the pulmonary artery; (3) a straight interface confined to the level of the pulmonary artery; (4) a straight interface at the level of the pulmonary artery, but which continues cephalad to overlie part or all of the aortic "knuckle." This interface, as noted above, can extend even into the medial soft tissues of the apex, and must not be confused with the paraspinal interface or with the left di-

Fig. 6. Border between left lung and heart (A), presents as a sharp roentgenologic interface because it is perpendicular to the incident ray.

verging component of the anterior mediastinal line, which also can transsect the aortic "knuckle" and extend into the medial soft tissues of the apex. This straight interface is usually medial to the lateralmost contour of the aortic "knuckle," but occasionally is tangent thereto, and rarely, slightly lateral. The interface tangent or slightly lateral to the "knuckle" occurred in only 2 per cent of the normal material surveyed by Blank and Castellino.2 Failure to recognize that under certain technical conditions this pattern of interface may normally occur considerably lateral to the "knuckle" may lead to serious diagnostic error, but the presence of such tissue in a far lateral position raises the suspicion of neoplasm, dissecting aneurysm or anomalous vessel.1,4

Figure 4 is a supine anteroposterior bed-

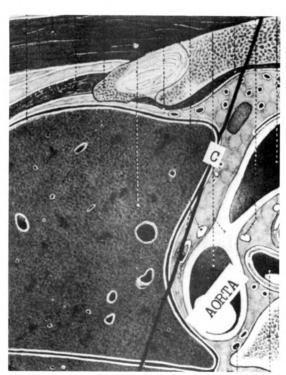


Fig. 8. "C" is continuous with "B" in Figure 7, and corresponds with the upper 2 arrows in Figure 5. The line drawn obliquely through "C" shows how, with sufficient geometric distortion of anterior structures in a corpulent subject in the anteroposterior projection, this interface can be projected *lateral* to the aortic arch.

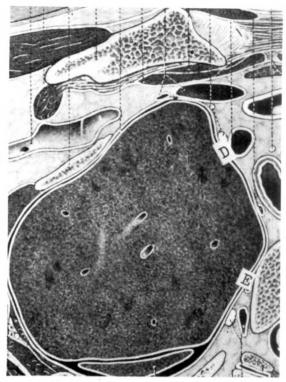


Fig. 9. "E" indicates the substrate for the left paraspinal interface above the aortic arch (see Figure 2). "D" indicates the substrate for the interface between left lung and subclavian artery (see Figure 1). These 2 interfaces would not be expected in roentgenograms of this anatomic subject because they are deficient in "perpendicularity. Further, the origin of the left common carotid artery in this subject must have been from the innominate artery (anteromedial to the subclavian artery), and an interface with the left lung would thus not be expected at this level (see Figure 1). (This and the previous 3 figures have been adapted from Eycleshymer and Schoemaker: A Cross-Section Anatomy. Appleton-Century-Crofts, New York.)

side study of the chest of a corpulent 70 year old man with severe hypertension and pain in the chest and back. The position of the mediastinal-left lung interface considerably lateral to the "knuckle" led to the suspicion of a dissecting aneurysm of the descending thoracic aorta, in view of the clinical setting. His precarious clinical state led to a decision for medical management without further diagnostic studies. A later supine anteroposterior bedside study during convalescence presented es-

sentially the same findings, and a standard teleroentgenogram done at the same time disclosed findings identical to those of a standard study taken I month before the onset of his acute symptoms (Fig. 5); a dissection was thus effectively excluded.

Figures 6, 7, 8 and 9 offer a rational explanation for the soft tissue-air interface lateral to the "knuckle." The expected geometric distortion of the more anterior mediastinal structures was exaggerated by their increased distance from the film in this corpulent patient with a little scoliosis and by the limited target-film distance inherent in the supine bedside study.

#### SUMMARY

The numerous contacts of the left lung with the mediastinum and its contents have characteristic roentgenologic counterparts which must be recognized to avoid error of over- or under-diagnosis.

In particular, the interface between the left mediastinum and the lung anterior to the pulmonary artery and the aortic arch, when roentgenologically present, is projected medially to the aortic "knuckle," or tangent thereto. When this interface is

lateral to the "knuckle," the possibility of excessive geometric distortion must be considered before the suspicion of an abnormal mediastinum is raised.

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## MYCOPLASMA PNEUMONIA\*

# CLINICAL AND ROENTGENOGRAPHIC PATTERNS

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1 YCOPLASMA pneumonia may present in a variety of ways. A recent paper emphasizes these variations.<sup>30</sup> One author has stated that the infiltrate is of a lobar segmental type,19 while others have found the infiltrates to be mainly reticular or interstitial.1,14,20,27,33 Some authors emphasize bilateral lower lobe involvement,20 while others report unilateral infiltration in 86 to 90 per cent of cases.14,17 Pleural effusion is considered rare, 19 but this has recently been reported in 6 of 29 adult cases, <sup>13</sup> and in 6 of 6 pediatric cases. <sup>18</sup>

Because of these confusing reports and obvious discrepancies, we have recently evaluated retrospectively 100 consecutive cases of Mycoplasma pneumonia seen at the Yale-New Haven Hospitals over the past 3 years. The study population consisted of both hospitalized and ambulatory patients. Sera for antimycoplasma antibodies were drawn when Mycoplasma pneumonia was suspected clinically. Titers were measured using the complement fixation technique described by Eng.9 In all cases the diagnosis of Mycoplasma pneumonia was made on the basis of clinical and roentgenographic findings as well as a fourfold rise in titer of complement fixing antibody.

## ROENTGENOGRAPHIC AND CLINICAL ASPECTS

Among 100 patients with Mycoplasma pneumonia we have observed 2 distinct groups of patients who together comprise 76 per cent of the cases investigated. These 2 groups presented with distinctly different clinical and roentgenographic findings. They did not differ significantly as to age, race or sex (Table 1).

Forty-eight patients presented with symptoms characteristic of an acute pneumonic process: non-pleuritic chest pain, cough, myalgias, and fever. Chest roentgenograms showed segmental or lobar consolidation with associated air bronchograms and, occasionally, atelectasis (Fig. 1). Unilateral involvement was noted in 31 cases. Pleural effusions, obvious on posteroanterior roentgenograms, were present in 9 cases (Fig. 2). Four of these effusions were grossly hemorrhagic. Two patients underwent pulmonary angiography for diagnosis. Both angiograms were normal. Pulmonary function was evaluated in 14 patients. Hypoxia with pO2 of less than 75 mm. Hg was found in 4 patients. The associated pCO2 was normal. All 14 had normal vital capacity and FEV1 determinations. Patients treated with appropriate antibiotics (erythromycin, tetracycline) responded clinically and roentgenographically, clearing pulmonary

TABLE I CLASSIFICATION OF CASES

•	Num- ber	Per Cent	Mean Age	Sex	Race
Group I	48	(48)	26	M20 F28	W38 B14
Group II	28	(28)	36	M18	W12 B16
Group III	24	(24)	28	M13 F13	W14— B12—

<sup>\*</sup> Presented at the Seventy-fifth Annual Meeting of the American Roentgen Ray Society, San Francisco, California, September

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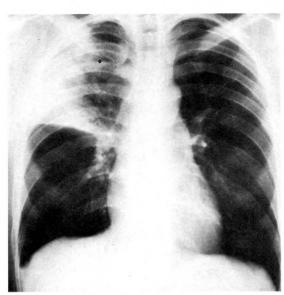


Fig. 1. Chest roentgenogram showing upper lobe segmental consolidation.

infiltrates within 5 to 14 days. Four patients within this first group had systemic lupus erythematosus, 3 had sickle cell disease, and 3 had Hodgkin's disease. The patients with sickle cell disease had complicated prolonged illnesses.

A second group of 28 patients presented with symptoms of longer duration: malaise, lethargy, and a 1-4 week history of shortness of breath. In contrast to the first group, these patients were usually afebrile and free from cough, myalgia, and chest pain. Chest roentgenograms showed bilateral diffuse reticulonodular infiltrates extending from the hila to the periphery with occasional Kerley B lines (Fig. 3; and 4). None showed lobar or segmental consolidation. Only I patient had a pleural effusion. Pulmonary function was evaluated in 19 patients: hypoxia with pO2 of less than 75 mm. Hg was found in 13 cases. Unlike the hypoxic patients in the first group, these patients also had an associated low pCO<sub>2</sub>. Sixteen of 19 had a decreased vital capacity with normal FEV<sub>1</sub>. These abnormalities are consistent with either restrictive or diffusion defects or both together. Appropriate antibiotic therapy did not appear to affect the clinical

symptoms or the roentgenographic abnormalities over a 2-4 week period. Ten patients continued to have abnormal chest roentgenograms for 3 months following the acute episode of *Mycoplasma* pneumonia. Within this group of patients, 8 had sarcoidosis and I had Hodgkin's disease.

The remaining 24 patients had such variable clinical and roentgenographic findings that specific categorization is not possible. Some presented with classic symptoms of pneumonia, while others presented with less specific complaints. Fifteen of these 24 patients had normal chest roentgenograms; 9 had roentgenograms demonstrating local or diffuse disease or both. Response to antibiotics was variable. In effect, these patients represent an overlap of the populations of Group I and Group II.

#### DISCUSSION

Our survey confirms the findings of many other authors: *Mycoplasma* pneumonia may present with either segmental consolidation or diffuse reticulonodular infiltration.<sup>30</sup> Upper lobe involvement occurs frequently enough that this finding by no means excludes *Mycoplasma* pneumonia from a differential diagnosis.<sup>29</sup> Pleural effusion is not an uncommon finding, and is more commonly associated with the pattern of lobar or segmental consolidation.<sup>30</sup> Patients with accepted autoimmune aberrations in our study, 4 with systemic lupus



Fig. 2. Chest roentgenogram showing massive left pleural effusion which was grossly hemorrhagic.

erythematosus on steroids, and 3 with Hodgkin's disease, generally display lobar or segmental consolidation. One patient with Hodgkin's disease had the interstitial edematous pattern referred to by Jansson et al.20 The 3 patients with sickle cell disease had prolonged difficult courses, as has been reported by Shulman et al.28 Although response to antibiotics is difficult to evaluate, as the disease may have a short course,22 those patients in Group 1 treated with erythromycin or tetracycline seemed to have rapid improvement both clinically and roentgenographically, as noted by Kingston et al.23 In some instances, Mycoplasma pneumonia may be a protracted illness associated with markedly abnormal pulmonary function.2,30 Severity of disease does not correlate with level of antimycoplasma antibody titers.8,30

The existence of 2 distinctive clinical and roentgenographic responses to infection with Mycoplasma pneumoniae remains to be explained. The patients in Group II with indolent symptoms and reticulonodular infiltrates presented a particularly confusing clinical picture. Multiple diagnoses were considered: congestive heart failure, sarcoidosis, collagen vascular disease, hypersensitivity pneumonitis, and even lymphangitic spread of tumor. This apparently modified response to Mycoplasma pneumoniae may be the result of underlying lung disease, previous exposure to Mycoplasma pneumoniae, or differing immune responses.

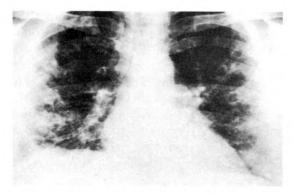


Fig. 3. Chest roentgenogram showing bilateral peripheral reticulonodular infiltrate.



Fig. 4. Chest roentgenogram showing bilateral diffuse reticulonodular infiltration extending from hila to periphery.

The association of elevated antimycoplasma antibodies and chronic lung disease has been investigated by several authors. 5,24,34 Lambert24 found significantly elevated antimycoplasma antibody titers in patients with chronic bronchitis and obstructive lung disease compared with normal controls. However, the incidence of acute illness associated with rise in titers was very low. The chest roentgenograms of those patients with Mycoplasma pneumonia, when described, demonstrated either no change, or increased parenchymal markings. No case of lobar or segmental consolidation is described. Of our 28 patients with the reticulonodular pattern, 8 had obvious underlying parenchymal lung disease in the form of sarcoidosis. In addition, 8 others had abnormalities of pulmonary function indicative of restrictive lung disease, diffusion defects, or a combination, both during acute illness and during prolonged convalescence. These functional abnormalities persisted, in some cases, beyond the return of the chest roentgenogram to normal limits. Berven<sup>2</sup> has demonstrated similar functional abnormalities in some cases far beyond the 3 month study period. That underlying parenchymal disease, in this case sarcoidosis, may modify the roentgenographic appearance is hardly surprising. Long term followup of patients in Group II not having sarcoidosis is needed to evaluate the possibility of early underlying parenchymal disease.

A second explanation for differing roentgenographic and clinical response to Mycoplasma pneumoniae may be related to a history of previous exposure to the organism. Chanock<sup>3,4</sup> and Rifkind et al.<sup>26</sup> have demonstrated that the presence of antimycoplasma antibody in titers of greater than I to 10 confers protection from illness but not infection, as shown by fourfold increase in antibody titer following challenge, positive culture of throat specimens, and the absence of associated illness. There is one report of naturally acquired reinfection with Mycoplasma pneumoniae, 15 but unfortunately, no roentgenogram is described. To date, there is no good method of serologic detection of prior infection with Mycoplasma pneumoniae. Complement fixing antibody tends to disappear with time,24 and thus the historical significance of a negative antimycoplasma antibody titer is not known. Other assays for Mycoplasma infection such as tetrazolium reduction inhibition to measure growth inhibiting antibody,<sup>21</sup> or hemagglutination inhibition<sup>10,31</sup> may be of help in this regard. The latter may be positive for 10 years.31 Pre-infection antimycoplasma antibody titers are not, of course, available for either groups of our patients. In a susceptible population, with a high incidence of Mycoplasma infection, serologic evidence should be sought to evaluate the possibility that a modified clinical and roentgenographic response to Mycoplasma pneumoniae may be the result of an anamnestic reaction.

A third possibility relates to the "role" of humoral and cellular immunity. Clyde and Bienenstock, working with Syrian hamsters, have shown that initial infection with Mycoplasma pneumoniae introduced intranasally produces a peribronchial infiltrate with numerous immunoglobulin staining cells. Rechallenge produces an infiltrate of similar distribution, but with immunoglobu-

lin negative small lymphocytes "reminiscent of a delayed hypersensitivity response." In another paper, 11 a similar serologic response was induced with killed organisms given intraperitoneally, yet rechallenge with intranasal innoculation produced clinical pneumonia. Other authors have reported that antimycoplasma defense mechanisms include "lymphokine" mediated macrophage activation, 1,6,11 a characteristic of delayed hypersensitivity. Eight of the patients in Group II had sarcoidosis and were shown to be anergic. Unfortunately, none of the other patients in Group II was evaluated in this regard. The manifestations of Mycoplasma pneumonia in immunodeficiency states have been previously reported. 16 The relationship of anergy to the clinical and roentgenographic expressions of Mycoplasma pneumonia warrants a further investigation.

Mycoplasma pneumonia provides a unique example of an infectious disease in which autoantibody directed against lung tissue appears early in convalescence. Likewise, false positive serological tests for syphilis, cold hemagglutinins, and agglutinins for a serologically distinct streptococcus have been demonstrated in some phase of active infection.32 It is quite conceivable that Mycoplasma pneumoniae possesses special immunological problems for certain hosts. The variability of the pulmonary infiltrates may be the result of antigenantibody reaction in areas of the lung adjacent to the bronchial tree, whereas the organisms themselves have been located primarily in the bronchial epithelium.7 It is conceivable that a few infected individuals may develop a hypersensitivity reaction to a modified tissue product, possibly of pulmonary origin. The roentgenographic response of patients in Group II to Mycoplasma pneumoniae may not be a manifestation of infection with the organism, but rather an altered host response to some form of antigenic stimulus.

#### SUMMARY

Our study of 100 patients with Myco-

plasma pneumonia has confirmed the findings of many other authors.

Mycoplasma pneumonia may involve upper as well as lower lobes, may be unilateral or bilateral, may be associated with pleural effusions, and may appear roent-genographically as segmental consolidation or diffuse reticulonodular infiltrates.

In addition, we have noted 2 distinct clinico-roentgenographic syndromes: symptoms suggestive of acute bacterial pneumonia are associated with the lobar segmental pattern, while non-specific symptoms accompanied by dyspnea are associated with the reticulonodular pattern.

The existence of underlying parenchymal lung disease, history of previous infection, and differing immune defenses are discussed as factors which may be involved in apparently different responses to the same infectious agent.

More sensitive serologic and culture methods are needed for further investigation of these syndromes.

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# STERNAL ANOMALIES AND CONGENITAL HEART DISEASE\*

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THE association of congenital heart disease and premature fusion of sternal segments is well recognized. However, the incidence of sternal fusion anomalies in the general population, and the significance of a chance finding of such an anomaly in relation to congenital heart disease are not known and were the subject of the present investigation.

Of 1,915 children who had consecutive chest roentgenograms at the Adelaide Children's Hospital for various reasons, 135 had anomalies of sternal fusion, and 1 in 5 of these had proved congenital heart disease. A by-product of the study was the finding that double manubrial ossification centers, known to occur in mongols, is a common condition, but only a few of those found by chance proved to be mongols.

## ANATOMY

The sternum develops in cartilage from mesoderm; by the ninth intra-uterine week the cartilage model has assumed its definitive shape and is continuous with the costal cartilages laterally, but lacks segmentation.<sup>2</sup> The manubrium ossifies from I or occasionally 2 centers during the fifth intra-uterine month. When there are 2 centers, they are seen to lie one above the other in the lateral roentgenogram (Fig. I).

The 4 segments for the body of the sternum develop separately; each may be represented by either I or 2 ossification centers, lying side by side (Fig. 2; and 3). The uppermost body center commences to ossify during the fifth or sixth intra-uterine month and the others ossify in sequence from above downwards with the fourth center appearing during the first year after birth. The xiphisternum does not ossify be-

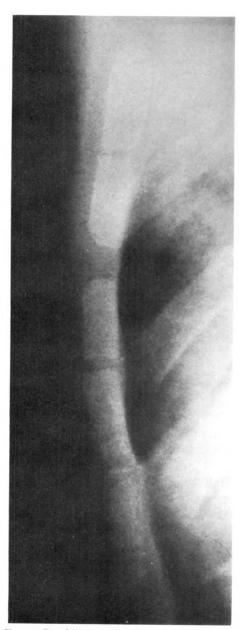


Fig. 1. Double manubrial ossification center.

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<sup>\*</sup> Presented at the 24th Annual Scientific General Meeting, Royal Australasian College of Radiologists, Sydney, Australia, September 30-October 6, 1973.

# CENTRES OF OSSIFICATION OF STERNUM

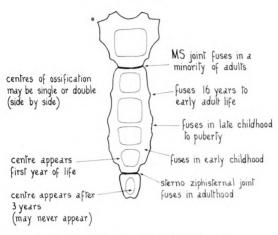


Fig. 2. Centers of ossification of sternum.

fore the third year and may remain cartilaginous throughout life. Fusion between the 4 body ossification centers occurs in the opposite sequence to their appearance, namely from below upward, beginning in early childhood, and is completed by early adult life. The xiphisternal and manubriosternal joints fuse in only a minority of adults.

#### MATERIAL AND METHOD

The films of 1,991 different children who had consecutive chest roentgenograms for various reasons at the Adelaide Children's Hospital during the first 3 months of 1972, were re-examined to detect anomalies of sternal and manubrial ossification. The children were of all ages up to 14 years. Seventy-six examinations had to be rejected either because they did not include a lateral film of the sternum, or the definition of sternal anatomy was inadequate. This resulted in 1,915 films which were examined for both anomalies of sternal fusion and multiple manubrial ossification centers. The case records of each child in which one of the above anomalies was found were searched for reference to congenital heart disease, in the case of sternal anomalies, and any other congenital anomalv in the case of multiple manubrial ossification centers.

A separate group of 88 children with

known congenital heart disease was randomly selected from the files of the Cardiac Clinic of the Adelaide Children's Hospital, and their roentgenograms were examined for premature fusion of sternal segments.

#### RESULTS

Three patterns of premature fusion of sternal segments were identified:

- 1. The 4 sternal segments were completely fused at the time of examination (Fig. 4)
- 2. Premature fusion of segments in the usual order (from below upward) (Fig. 5)
- 3. Premature fusion in an abnormal or-



Fig. 3. A normal sternum showing both double and single ossification centers.

der (upper or middle segments fusing before lower ones) (Fig. 6)

#### PREMATURE STERNAL FUSION

One hundred and thirty-five of the 1,915 (7 per cent) children studied had prematurely fused sternal segments of one of the types mentioned above. Review of the case records of these patients showed that 24 now have proved congenital heart disease and that 2 others, who had not been ex-

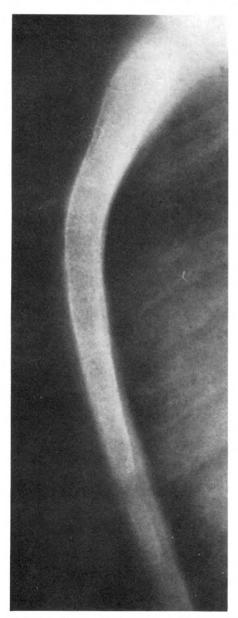


Fig. 4. A completely fused sternum. The xiphisternum remains unfused.

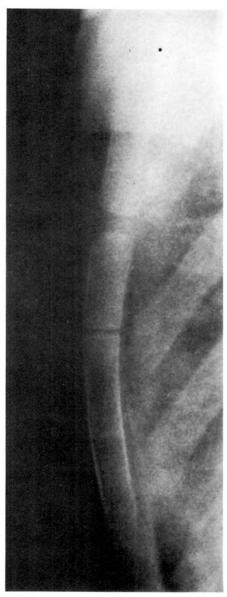


Fig. 5. Premature fusion of sternal segments occurring from below in an infant. The second and third ossification centers do not normally fuse until late childhood or puberty.

tensively investigated, have cardiac murmurs, and I of these had electrocardiographic and radiographic abnormalities which also suggest heart disease. The incidence of association of congenital heart disease did not vary among the 3 patterns of abnormal sternal fusion. Ventricular septal defect (V.S.D.) was the commonest associated cardiac lesion (Table I).

In the group of 88 children with known



Fig. 6. Premature fusion of sternal segments from above. The first and second sternal ossification centers normally fuse in the late teens or early adult life.

congenital heart disease, 17 (19.3 per cent) had prematurely fused segments. Again, V.S.D. was the most frequent cardiac lesion noted in these 17 cases (Table II).

Multiple manubrial ossification centers were found in 118 of the 1,915 children (6.5 per cent). All patients had 2 ossification centers except for 1, in which 3 were pres-

ent. These patients had a wide spectrum of other anomalies but only 4 were mongols (Table III).

#### DISCUSSION

In 1956, Monet et al.8 reported a case of premature fusion of the sternal segments in a child with congenital heart disease. Two years later, Currarino and Silverman<sup>3</sup> published a series of isolated examples of the same association. Since then further isolated examples have been reported,1,6 and recently reviews of sternal anomalies in groups of children with known congenital cardiac disease have been published.5,9 Previous papers have given no incidence of the occurrence of abnormalities of fusion of sternal segments in the general pediatric population, or expressed the significance of such a chance finding. Our study of a hospital population of children up to the age of 14 years has shown a 7 per cent incicidence of sternal fusion abnormalities. Furthermore, just less than I in 5 of these was associated with congenital heart disease. The potential ability to predict previously unrecognized congenital heart disease as a result of an isolated finding of sternal fusion anomalies and the relatively high incidence of these anomalies in the general pediatric population may be of practical importance.

Recently, White *et al.*<sup>9</sup> have reviewed 119 children with known congenital heart disease and found a 59 per cent incidence of associated premature fusion of the sternal

TABLE I

TYPES OF CONGENITAL HEART DISEASE ASSOCIATED
WITH STERNAL FUSION ANOMALIES

Ventricular Septal Defects	13	
Patent Ductus Arteriosus	5	
Conduction Defects	2	
Corrected Transposition	I	
Atrial Septal Defect	1	
Complex Anomalies	2	
	· —	
	24	out of 135 sternal abnormalities

# Table II

# MULTIPLICITY OF OSSIFICATION IN VARIOUS TYPES OF CONGENITAL HEART DISEASE

Ventricular Septal Defects	5	
Pulmonary Stenosis	3	
Patent Ductus Arteriosus	2	
Tetralogy of Fallot	2	
Aortic Stenosis	2	
Atrial Septal Defect	1	
Cushion Defect	I	
Dextroversion	1	
	17	out of 88 known congenital heart disease

body segments. Our population of patients with congenital heart disease was also small (88 patients), but only showed a 17 per cent incidence of sternal anomalies.

#### CONCLUSION

Many types of congenital heart disease were associated with sternal fusion anomalies but ventricular septal defect was the most common (Table 1). This is in agreement with the findings of Fischer *et al.*<sup>5</sup> in their group of acyanotic children and adolescents.

Multiple manubrial ossification centers were less common (6.5 per cent) than suggested by Horns and O'Loughlin<sup>7</sup> (15 per cent), and Currarino and Swanson<sup>4</sup> (20 per cent), but these latter reports related to groups of children under the age of 5 years, whereas ours ranged up to 14 years of age. Our patients with manubrial segmentation had a wide spectrum of other anomalies, but only 4 were mongols (Table III). Although duplication of the manubrial center occurs frequently in mongolism, the incidence of mongolism among children found by chance to have multiple manubrial ossification centers is low.

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TABLE III

#### MULTIPLE MANUBRIAL OSSIFICATION CENTERS

Congenital Anomalies	19	out of 118 with multiple ossifi- cation centers
Mongols	4	
Spina Bifida	4	
Congenital Heart Disease	4	
Celiac Disease	2	
Tracheo-Esophageal Fistula	1	
Pierre Robin and Cleft Palate	I	
Mucoviscidosis	1	
Thalassemia	1	
Muscular Dystrophy	1	

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# MECHANICAL DEVICES FOR ARTERIAL OCCLUSION

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RANSCATHETER arterial embolization has had an increasing application in the control of bleeding of non-neoplastic origin; i.e., gastrointestinal bleeding, 3,4,23,27,28 traumatic renal<sup>5</sup> and pelvic bleeding,<sup>21,26</sup> hemoptysis<sup>24</sup> and epistaxis.<sup>29</sup> This approach has also been utilized in the treatment of tumors18 and arteriovenous malformation<sup>6,7,13,17,20</sup> of the central nervous system; bleeding gastrointestinal<sup>11</sup> and uterine neoplasms;11 and the preoperative and palliative management of renal carcinomas.1,12,15 The materials used for embolization include autologous tissue and clot,1,25,31 clot augmented by thrombin, platelets, 4,5,11 etc., gel foam,12 metallic and silastic spheres,14 a variety of silicone preparations, 8,19 isobutyl-2-cyanoacrylate,9 and radioactive particles. 16 In the search for safer, more permanent, and easily injectable materials, two mechanical devices for the embolization of small and large arteries are described in this presentation.

#### MATERIAL AND METHOD

In view of the requirements created by different arterial diameters and the necessity for both central and peripheral occlusions, 2 types of mechanical occluding devices were formulated; cotton tails for smaller arteries; and wool coils for larger vessels.

#### COTTON TAILS

These emboli consist of 3 mm. segments of No. 19 gauge steel tubing to which are attached 8 strands of cotton threads, 5 mm. in length (Fig. 1).

A preshaped No. 6 French polyethylene catheter of uniform internal diameter with a non-tapered tip was introduced into the surgically exposed femoral artery of 10 anesthetized dogs. Selective catheterization of the artery to be embolized was accomplished. The catheter was then gently kinked approximately 10 cm. from the stopcock, obstructing reflux of blood. The cotton tails were impaled on the centrally tapered mandril of a No. 20 gauge Karras needle and inserted into the catheter through the opened stopcock. The mandril and then the needle were withdrawn leaving the embolus in place in the catheter. A syringe containing saline was attached and the lumen of the catheter was reopened by straightening the catheter. Saline was injected to push the cotton tail through the catheter into the artery (Fig. 2). The embolus was transported by the blood stream along the direction of greatest flow until it lodged in a small artery or at a bifurcation. This usually occurred when

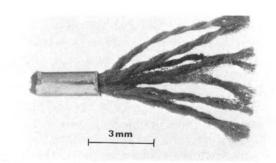


Fig. 1. The No. 19 gauge steel tubing is 3 mm. in length, and the cotton threads are 5 mm. in length.

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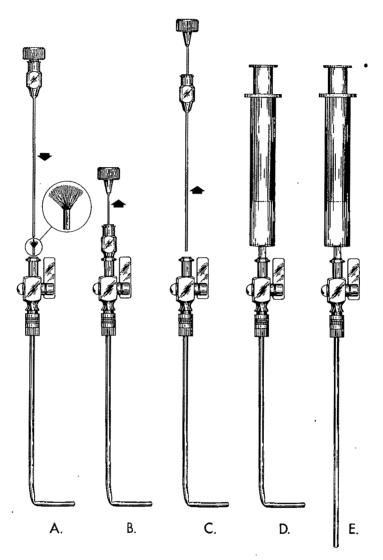


Fig. 2. Technique for embolization of cotton tail.

the arterial diameter was 2 mm. or less. This technique has been employed in dogs to occlude branches of the coronary, renal, celiac and superior mesenteric arteries (Fig. 3).

### WOOL COILS

These devices for the occlusion of larger arteries were constructed by attaching 4 woolen strands, 3 cm. long, to a tightly coiled 5 cm. long segment of steel guidewire from which the central core had been removed (Fig. 4).

A preshaped No. 7 French thinwall

Teflon catheter with uniform inner diameter and non-tapered tip was introduced into the surgically exposed femoral artery of 10 anesthetized dogs. The arteries to be embolized were selectively catheterized. To facilitate passage through the Teflon catheter these steel coils with woolen tails were straightened by an introducer. The introducer consisted of a fine wire mandril protruding from a long piece of No. 19 gauge steel tubing which fit inside the catheter and was long enough to deposit the coil near the terminal curve of the catheter. The coil was left within the catheter by withdrawing



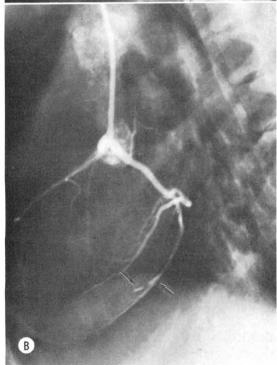


Fig. 3. Embolization of cotton tails.

- (A) Canine renal arteries embolized with cotton tails.
- (B) Canine coronary artery embolized with cotton tail.

Note the peripheral position.

the mandril and the introducer. The coil was then pushed into the arterial lumen with a modified 0.045 inch guidewire. The

wool coil formed an embolus of steel and wool at a point immediately distal to the catheter tip (Fig. 5).

This device has been used to occlude canine superior mesenteric, renal, hepatic, splenic, carotid and iliac arteries (Fig. 6). Re-examination 2 weeks after the procedure revealed persistent occlusion.

#### ILLUSTRATIVE CLINICAL CASE

Preoperative occlusion of the renal artery was performed in a patient with a hypernephroma. This was accomplished with the use of wool coils.

A mylar sheath catheter was introduced percutaneously into the right femoral artery of a 45 year old male with a left hypernephroma. Through the mylar sheath a thinwall preformed, No. 7. French catheter of uniform inner diameter and non-tapered tip was passed with the assistance of a 0.045 inch guidewire. The left renal artery was selectively catheterized. Utilizing the procedure previously described, 4 coils were used to occlude the vessels supplying the majority of the neoplasm. The next day at the time of the left nephrectomy the surgeon commented about the ease of the operative procedure and the relative avascularity of the kidney and the neoplasm. The coils did not interfere with the ligation of the renal artery (Fig. 7).

#### DISCUSSION

An arterial bed can be obstructed from the periphery by occluding multiple small arteries or centrally by occluding a few larger arteries. The occlusion of small arteries by small emboli is more gradual and usually requires multiple injections. As the obstruction proceeds, the blood flow is gradually decreased. Rapid injection at that point may result in reflux of the emboli into territories at a distance from those intended. Central occlusion on the other hand requires larger and fewer emboli. This approach is more likely to result in collateral circulation to the vascular bed if given adequate time.

At M. D. Anderson Hospital 25 patients with a variety of malignant neoplasms were treated by transcatheter arterial emboliza-

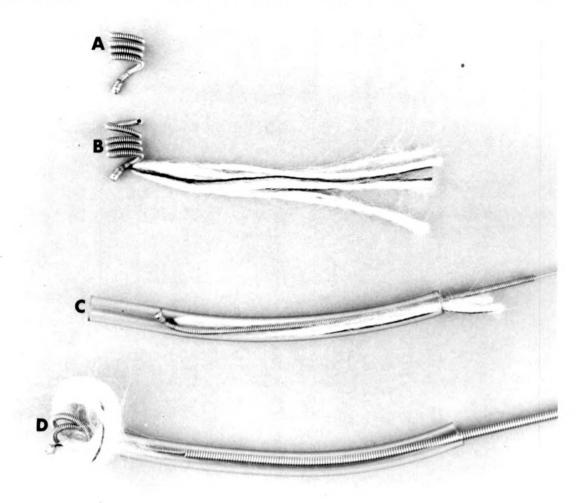


Fig. 4. Wool coil.

- A. The coiled wire segment, 3 cm. long.
- B. The coil with attached woolen strands 6 cm. long.
- C. The straightened wool coil within a clear plastic tube.
- D. The reformation of the wool coil, as it emerges from the catheter.

tion. One group of 7 patients with neoplasms was treated by arterial embolization to control bleeding which was refractory to more conservative management. These patients were poor surgical candidates. Successful treatment of the immediate problem of hemorrhage allowed time for definitive therapy for the primary disease. These included patients with lymphoma of the stomach, invasion of the sigmoid colon by an ovarian carcinoma, and choriocarcinoma of the uterus.

The majority of the patients, 18 of the 25, had renal carcinomas and occlusion of

the renal arteries was performed. In 9 of these patients occlusion was done preoperatively to reduce tumor vascularity. By decreasing arterial supply the venous drainage was markedly diminished, technically facilitating the nephrectomy. In the 9 patients with inoperable renal carcinoma, transcatheter arterial embolization was performed palliatively to reduce tumor bulk and to relieve symptoms of flank pain and hematuria.

Autologous clot, subcutaneous tissue, 5 mm. segments of stainless steel guidewire, and Gel Foam were utilized as the

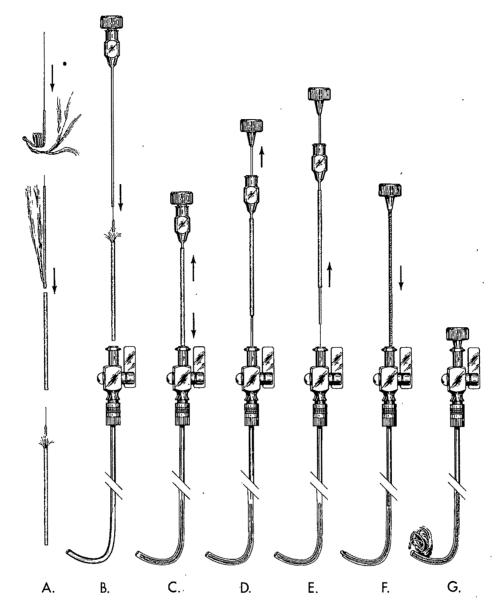


Fig. 5. Technique for embolization of wool coil.

embolic materials. At times a combination of these materials was used. Autologous clot was of temporary duration, lasting days prior to lysis. Subcutaneous tissues have the natural disadvantage of limited supply. The wire segments alone were ineffective in that they seemed to come into equilibrium with the blood stream after a thin coat, presumably fibrin, formed about the metal. Gel Foam was employed most frequently to occlude the small as well as the large

arteries. In a few of these patients a portion of the vascular supply was patent on follow-up arteriographic examination. All of these small particles run the risk of reflux from the embolized vessel as the vascular bed is occluded. This same problem would occur with the cotton tails. As the cotton tails are radiopaque, the site of the occlusion is obvious. The cotton portion of the embolus is effective as the nidus for occlusion.

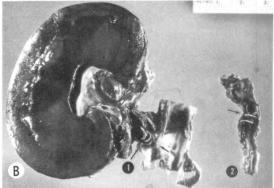
Fig. 6. Embolization of wool coils.

- (A) Occlusion of a canine renal artery with a wool coil.
- (B) Specimen:
  - (1) Wool coil in a canine renal artery. The occlusion is at the proximal portion of the renal artery.
  - (2) Wool coil in the splenic artery specimen.



The wool coils readily occlude the larger arteries just beyond the tip of the catheter. The use of a Teflon catheter has the disadvantage associated with the more rigid and therefore more traumatic catheter material. In view of the non-tapered tip, the introduction of the catheter is accomplished through a Mylar sheath. The great advantage of this device is the ability to place the embolus at the specific site desired. The last two hypernephromas were embolized successfully with the use of wool coils.





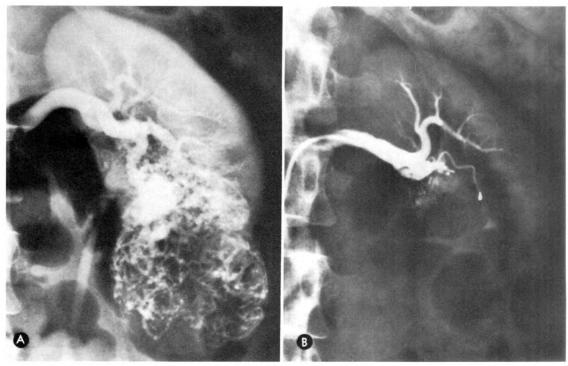


Fig. 7. Embolization of renal carcinoma.

- A. Renal carcinoma of the left lower pole.
- B. Occlusion of the branches of the renal artery supplying the neoplasm.

#### SUMMARY

Two mechanical devices for the purpose of occluding vessels are presented.

Cotton tails, small metallic segments with attached cotton threads, will effectively occlude small arteries of approximately 2 mm. in diameter.

Wool coils, 5 cm. segments of the outer portion of steel guidewires with attached wool strands, obstructed major vessels just beyond the tip of the catheter.

The use of these devices has been investigated in dogs and then applied clinically in the occlusion of renal arteries in patients with hypernephroma.

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## CYSTIC ADENOMATOID MALFORMATION OF THE LUNG\*

## MORPHOLOGIC ANALYSIS

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YSTIC adenomatoid malformation of the lung with its consequent, and at times severe, respiratory embarrassment is an important diagnosis in the pediatric age group. Thirty-one cases were analyzed at the Armed Forces Institute of Pathology for this study and of this group 15 had roentgenograms. The pathologic material or roentgenograms, or both, were reviewed in each case for better understanding of the roentgenographic patterns, gross and histologic morphology.

Analysis is first approached by evaluating the over-all pattern and stressing the roentgenologic appearance with correlating morphology. Secondly, a close investigation is made of cyst wall structures by comparing the roentgenograms with their corresponding histologic fields. The roentgenographic patterns range from a homogeneous mass to a multicystic lesion, or a dominant cyst with a multicystic background (Table 1).

The most common roentgenographic manifestation, present in II of I5 cases, is an expansile, multicystic pattern (Fig. 1A), showing various sizes of cysts and causing mediastinal shift with pulmonary herniation. It represents an accumulation of closely packed, interconnecting, adenomatoid cysts with considerable variation in size and wall thickness as shown in the cut gross specimen (Fig. 1B) and macrosection (Fig. 1C). Magnification of a thin wall (Fig. 1D) between 2 expanded cysts from the rectangular area (thick arrow) of the

macrosection (Fig. 1C) shows delicate, nonexpanded, intervening cysts interspersed with normal pulmonary parenchyma. The macrosection (Fig. 1C) also reveals the commonly present surrounding lung atelectasis (thin arrow) secondary to the expansion of these cysts.

The dominant cyst pattern (Fig. 2, A and B), present in 2 of 15 cases, is a unique pattern in that, although it represents the same basic underlying multicystic lesion, it contains I cyst expanding out of proportion to the surrounding cysts. This predominant expanded cyst restrains but does not completely stop the expansion of other adjacent cysts. The latter, then being only partially expanded, are seen roentgenographically as a surrounding nonhomogeneous density (Fig. 2A; arrows). A histologic field (Fig. 2C) from this latter area shows small partially collapsed adenomatoid cysts. This pattern can be so prominent that it may cause confusion initially with congenital lobar emphysema, but the surrounding

TABLE I SPECTRUM OF ROENTGENOGRAPHIC PATTERNS (15 cases)

Pattern	Number	Per Cent
Multicystic lesion Dominant cyst in multicystic	II	73.3
background	2	13.3
Solid homogeneous mass	2	13.3

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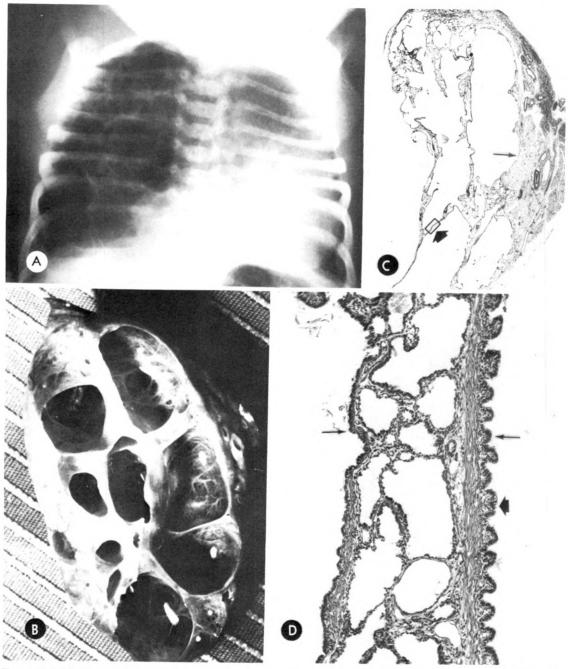
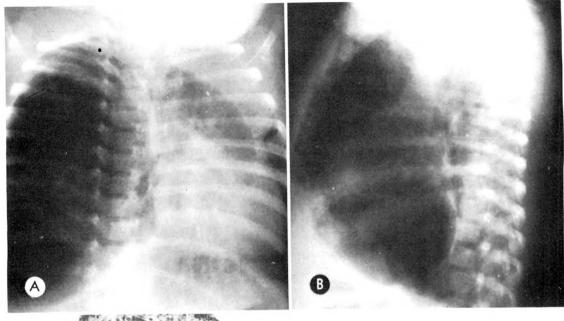


Fig. 1. (A) Multicystic lucent lesion containing cysts of various sizes in a combination of thick to thin walls and ridges. This is the most common roentgenographic pattern in cystic adenomatoid malformation. Air fluid levels are present in the cysts and their expansion has caused mediastinal shift with herniation of the right lung to the left via the anterior mediastinum. (B) The sectioned gross specimen confirms the roentgen impression of an over-all expanded cystic area with multiple interconnecting cysts of various sizes separated by thick walls and ridges. (C) A macrosection of the expansile cystic area further confirms the variation in cyst size and wall thickness. The major portion of the lesion is composed of large epithelial lined cysts. The adjacent normal lung (thin arrow) is compressed by the expansile cysts. For explanation of the rectangular area (thick arrow) see D. (H&E  $\times$ 2.) (D) Magnification of the rectangular area (C) demonstrates a thin wall (between thin arrows) separating 2 cysts. It is lined by cuboidal epithelium with papillary folds (thick arrow). (H&E  $\times$ 100.)



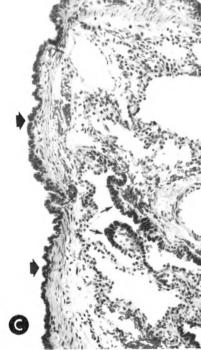


Fig. 2. (A) Dominant large cyst with nonhomogeneous surroundings (arrows) representing adjacent, more compact, only partially expanded adenomatoid cysts. Note how the expansion of the dominant cyst causes anterior pulmonary herniation and inversion of right hemidiaphragm. (B) The dominant large adenomatoid cyst is again shown in its anterior inferior location. The anterior mediastinal herniation is also appreciated as a retrosternal lucency. The comparison of the posteroanterior and lateral chest roentgenograms enhances awareness of the expansile character of these adenomatoid cysts and their consequent respiratory embarrassment. (C) Edge of the dominant cyst (thick arrows) with an underlying small partially collapsed adenomatoid cyst (thin arrows). The latter is lined by epithelium and surrounded by alveoli. (H&E ×110.)

partially expanded, nonhomogeneous cystic areas (not present in congenital lobar emphysema) should be a deciding factor in the differential diagnosis.

The solid homogeneous mass pattern (Fig. 3A), present in 2 of 15 cases, is an interesting and unusual presentation of cystic adenomatoid malformation of the

lung. It occurs when all the cysts happen to be filled with fluid at the time of roentgen examination (Fig. 3A). The gross specimen from this case (Fig. 3B) confirms the basic cystic character of the lesion. *In vivo* the visualized cysts had been filled with fluid, thus explaining the over-all consolidated homogeneous appearance at the time of

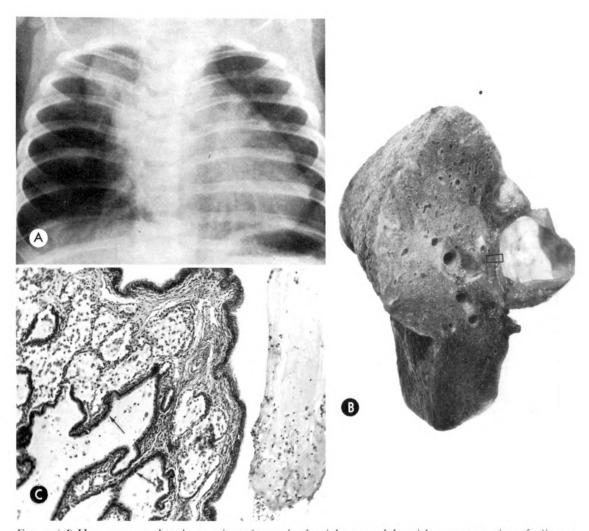


Fig. 3. (A) Homogeneous sharply marginated mass in the right upper lobe with no compression of adjacent lung or expansion. This patient had no respiratory distress because of the absence of significant expansion. (B) The cut gross specimen reveals several large cysts which were not seen roentgenographically, since they were filled with fluid and their bronchial communication had been occluded. The area adjacent to the wall of a larger cyst (rectangle) contains many nonexpanded adenomatoid cysts (see C). (C) Magnification of the rectangular area from B shows that the adjacent lung parenchyma contains fluid-filled small adenomatoid cysts (arrows) among the alveoli, confirming the diagnosis of cystic adenomatoid malformation. (H&E ×100.)

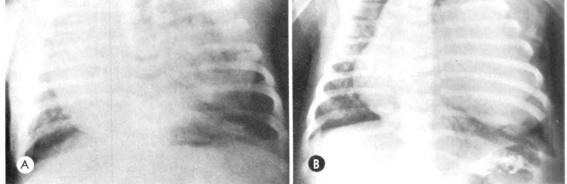


Fig. 4. (A) Multicystic lucent lesion with expansion and mediastinal shift in a patient with mild respiratory distress. (B) Solid homogeneous mass with expansion and mediastinal shift with no lucent areas taken 10 days after the presenting chest roentgenogram (A). This was due to superimposed infection of the cystic lucent areas.

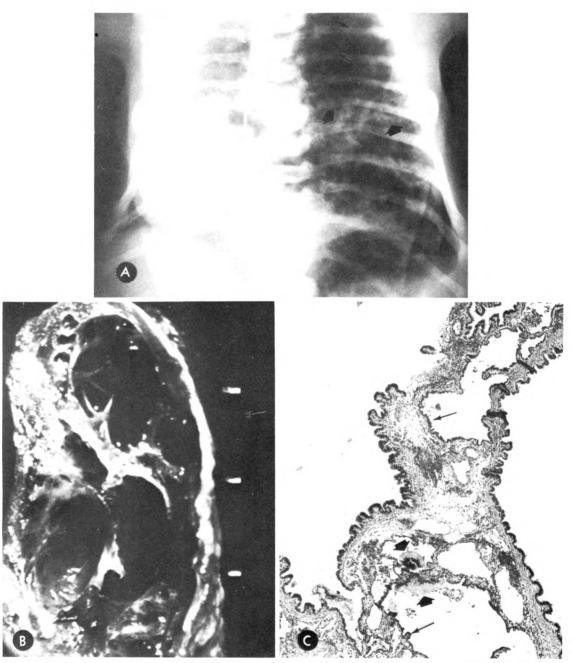


Fig. 5. (A) A lucent expansile multicystic lesion with cysts of various sizes which features thick cyst walls and ridges (thick arrows) in areas of minimal expansion and thin walls (thin arrows) in areas of greatest expansion. The mediastinal shift and compressive atelectasis of the right lung again are secondary to the expansion. (B) The gross specimen shows the interconnecting multiple cysts with thick ridges and walls corresponding to the histologic field (C). (C) A thick wall which correlates with the gross and roentgenographic findings just described is demonstrated between adjacent cysts. The wall contains blood vessels, alveoli, foci of mucogenic cells (thick arrows) and minimally expanded interposed adenomatoid tissue (thin arrows). (H&E  $\times$ 77.)

roentgenography. A microscopic field (Fig. 3C) from the wall of this fluid-filled cystic mass shows the retained fluid as well as numerous nonexpanded adenomatoid cysts. This case represents a solid mass pattern in a situation in which bronchial occlusion had prevented progressive expansion. The occlusion occurred early in the genesis of

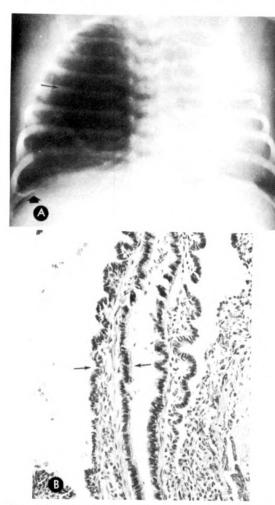


Fig. 6. (A) Lucent expansile multicystic lesion with thin delicate cyst walls (thin arrows). The mediastinal shift and partial compressive atelectasis of the left lung are secondary findings due to the expanding mass and are mainly responsible for the patient's respiratory distress. Note the secondary atelectasis of adjacent normal lung (thick arrows). (B) High magnification view through the thin delicate walls (between arrows) of these cysts. It is composed of a low columnar epithelial lining and minimal interstitial tissue. The area between the arrows corresponds to a thin wall seen on the roentgenogram (A, thin arrows). (H&E ×200.)



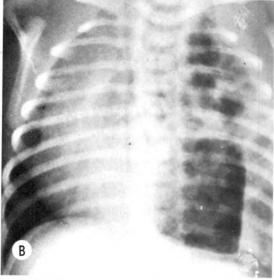


Fig. 7. (A) A supine chest roentgenogram with lucent multicystic areas with expansion, thick walls and ridges and mediastinal shift. No air fluid levels are demonstrated in this *supine* roentgenogram (but see B). (B) A left decubitus film in the same case now demonstrates air fluid levels. The fluid represents a combination of secretions from mucogenic areas and retained secretions from other indigenous sources. Note also the large variation in cyst

this lesion before the classic air-filled, expanded, multicystic pattern could develop and cause clinical symptoms. The roent-genogram therefore demonstrates the balance between early expansion and bronchial occlusion. It is also possible that an initially

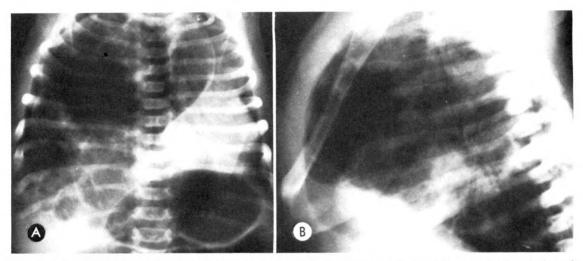


Fig. 8. (A and B) Multicystic expanding lucent lesion with one dominant cyst causing anterior herniation of the lung and inversion of right hemidiaphragm with ventilatory embarrassment and severe respiratory distress. Also noted is a small pneumothorax which is not a common finding in cystic adenomatoid malformation.

solid homogeneous mass may subsequently be cleared of fluid and appear as a classic multicystic, expanding, air-filled pattern on follow-up roentgenograms. Conversely, the solid mass pattern (Fig. 4B) may also be a late sequela following initial presentation as a multicystic lucent mass (Fig. 4A). This may occur whenever a secondary infection is superimposed on the initial multicystic lesion with subsequent fluid accumulation and expansion.

The 3 basic over-all gross and roentgenographic patterns have been discussed. Now, a closer look at the wall structure is in order. Such walls show a complex composition consisting of adenomatoid tissue and indigenous pulmonary parenchyma. These walls can be effectively studied in the roentgenologic-pathologic correlative findings in the case in Figure 5A. The gross specimen

for this case (Fig. 5B) shows the thick walls of the interconnecting, multiple, expanded cysts. Microscopic section (Fig. 5C) demonstrates 2 opposing expanded cysts with an intervening thick cyst wall containing minimally expanded adenomatoid cysts (thin arrows) and indigenous pulmonary parenchyma. Thinner walls (Fig. 6A, thin arrows) occur when cysts show greater expansion. Microscopically (Fig. 6B) these thinner walls show low columnar epithelium with minimal intervening interstitial tissue. In each case, of course, there may be a wide range of wall thickness and cyst size, and this variation is a fundamental feature of cystic adenomatoid malformation of the lung.

Another interesting feature of cystic adenomatoid malformation is the presence of fluid within the cysts. This fluid is due to

TABLE II

CLINICAL PRESENTATION

(30 cases)

Presentation	Number	Per Cent
Stillborn	5	16.7
Respiratory distress	22	73.3
No respiratory distress	3	10.0

Table III

AGE AT ONSET OF RESPIRATORY DISTRESS
(22 cases)

Number	Per Cent
15	68.2
I	4.5
6	27.3

a combination of secretions from mucogenic cells (Fig. 12) and retained indigenous fluid. Roentgenologically this is often demonstrated by the presence of air fluid levels (Fig. 7B). These were present roentgenographically in only 4 of the 15 cases, but it is very common for the pathologist to detect fluid within these cysts. If the proper roentgenographic technique for demonstrating fluid (Fig. 7B) was used, then more cases would show air fluid levels.

The clinical features of cystic adenomatoid malformation are also of interest. Respiratory distress is the hallmark, but it may not always be present (Table II). Note that there was no respiratory distress in 10 per cent, while 73 per cent showed it, and 17 per cent were stillborn. It occurs in 88 per cent, therefore, if we exclude the stillborn. This may be further analyzed with respect to the patient's age at the onset of respiratory dis ress (Table III). This reveals a distinct and predominant group which clusters in the first day of life with the onset of respiratory distress at birth or within the first few hours. This group accounts for 68 per cent of the symptomatic patients and the patient is usually a surgical emergency with significant mortality if left untreated. The respiratory distress is related to marked expansion of the adenomatoid cyst with secondary compromise in pulmonary ventilation. The roentgeno-

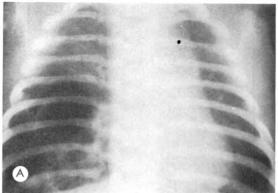
Table IV

DISTRIBUTION OF CYSTIC ADENOMATOID

MALFORMATION

(26 cases)

Right Lung	Left Lung		
14	12		
RUL—4	LLL—6		
RLL—4	LUL—3		
RML—I			
Combination—2	Left lung—lobe not speci- fied—3		
RLL & RML—1			
RLL & RUL—1			
Right lung—no lobe specified—3			



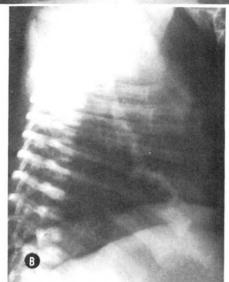


Fig. 9. (A) Multicystic lucent lesion with only minimal expansion and mediastinal shift and therefore no symptomatic respiratory embarrassment. In time, further expansion may cause the patient to become symptomatic. (B) Again we confirm the presence of a multicystic lucent lesion with only minimal expansion. Note that there are no changes in the thoracic cage volume nor inversion of the diaphragm.

grams in this group (Fig. 8, A and B) typically demonstrate an expansile multicystic lesion with anterior mediastinal herniation and inversion of the diaphragm. The other infants in this group have the onset of respiratory distress later with a wide range of variation from 2 days to 7 weeks of age. The respiratory distress is usually not so acute as in the earlier group, but there are significant sequelae, such as progression of expansion or superimposed infection with respiratory compromise. These may also

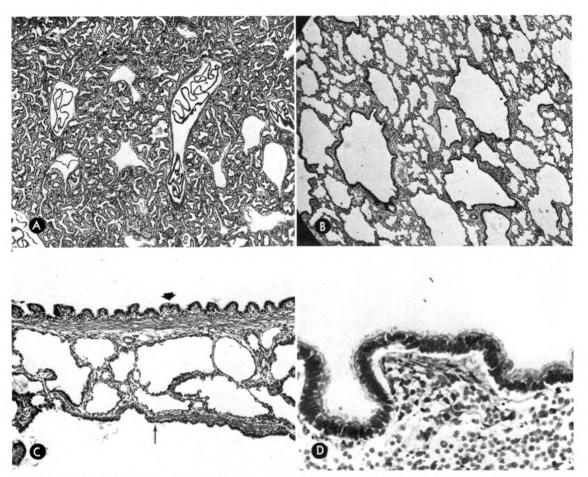


Fig. 10. (A) "Solid" pattern of cystic adenomatoid malformation is illustrated. Virtually all spaces except blood vessels are lined by cuboidal epithelium. Cartilage is not present in the walls of the larger bronchus-like cysts. (H&E×50.) (B) Intermediate type pattern of cystic adenomatoid malformation is shown. Cysts lined by cuboidal to low columnar epithelium are distributed among normal sized to slightly distended respiratory bronchioles and alveoli. (H&E×35.) (C) The wall separating two cysts is covered by cuboidal to low columnar epithelium in a smooth (thin arrow) to polypoid (thick arrow) configuration. The wall itself contains alveoli, blood vessels, and partially lined cysts. (H&E×100.) (D) A high power view of the polypoid lining of C (thick arrow) shows the ciliated tall columnar epithelial cells. (H&E×395.)

warrant surgical intervention.

No detectable respiratory distress occurred in 3 patients, and this is an unusual event. Each case was an incidental finding with 2 specific patterns. The first type with progressive expansion prevented by bronchial occlusion presented as a static homogeneous mass with no hint of the histologic diagnosis (Fig. 3A). Alternatively there occurred a multicystic lucent lesion (Fig. 9, A and B) typical of the roentgenographic pattern of cystic adenomatoid malformation, but in a patient with no re-

spiratory distress. The latter is unusual because the roentgenograms (Fig. 9, A and B) reveal some mild expansion which should suggest mild respiratory distress but which is not confirmed in this case by the physical or clinical findings. We are left with the explanation that this is a fortuitous finding and would certainly suggest that it is only a matter of time before respiratory distress will intervene because the underlying mechanism of bronchial communication and cyst expansion is present.

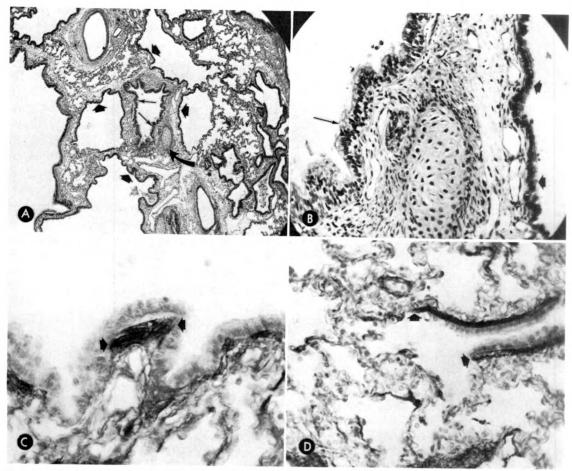


FIG. 11. (A) A "trapped" bronchus (thin arrows) is surrounded by adenomatoid cysts (thick arrows) of various sizes. Also note the cartilage of the "trapped" bronchus (curved arrow). (H&E ×35.) (B) A high power view from the wall of the "trapped" bronchus is illustrated. The island of cartilage separates the pseudostratified ciliated tall columnar epithelium of the "trapped" bronchus (thin arrow) from the ciliated cuboidal to low columnar epithelium of the adenomatoid cysts (thick arrows). (H&E ×220.) (C) The epithelial lining of a cyst covers a polypoid structure containing dark staining elastic tissue (arrows). (Elastic stain ×485.) (D) The dark staining elastic tissue and cuboidal epithelium terminate simultaneously (arrows) as they enter an alveolus-like space. (Elastic stain ×305.)

There was no apparent sex or racial predominance and 15 of the 31 infants weighed less than 2,500 gm. at birth. Anasarca has been reported in the literature, but was noted in only 2 cases of our series. One was a stillborn and the other was premature and died shortly after birth. Neither of these cases was studied roentgenographically.

The location of the lesions is shown in Table IV. There were 14 within the right lung and 12 in the left lung. The left lower lobe is the most commonly involved, but

this information is of little clinical help, since any lobe can be affected and the diagnosis is predicted by the roentgen pattern rather than by the distribution. The cases with a combination of 2 lobes involved are associated with severe respiratory distress. The survival time of these latter cases was so short that no roentgenograms were obtained.

#### PATHOLOGIC MORPHOLOGY

The microscopic criteria for the diagnosis of cystic adenomatoid malformation were

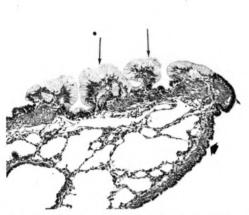


Fig. 12. Large mucin producing cells (thin arrows) are seen covering polypoid structures projecting into the lumen of a large cyst. Also note the more usual cuboidal epithelium lining the cysts (thick arrow). (H&E ×110.)

summarized by Kwittken and Reiner<sup>14</sup> as follows:

1. An "adenomatoid" increase of terminal respiratory structures as manifested by cysts of various sizes communicating with each other and variably lined with either a pseudostratified ciliated columnar (bronchial-type) epithelium or a single-layered cuboidal epithelium;

2. Polypoid configuration of the mucosa and increased amounts of elastic tissue in the walls of the cystic portions lined with bronchial-type epithelium;

3. Absence of cartilage plates in the cystic parenchyma except as constituents of nondeformed bronchial structures trapped within the diseased lung;

4. Occasional groups of alveoli lined with mucogenic cells; and

5. Absence of inflammation.

In the 25 cases available for current pathologic review at the Armed Forces Institute of Pathology, a broad spectrum of gross and microscopic patterns was seen. The gross pattern varied from a diffusely "solid" lesion, in which cysts were not visible, to the other extreme in which single or multiple cysts measuring up to 7 cm. in diameter comprised the malformation.

The solid pattern (Fig. 10A) was seen in 2 cases and consisted of multiple small cysts lined by cuboidal epithelium. The cysts ranged in size from that of a normal alveolus to slightly larger than normal terminal bronchioles. Only rarely within this type of lesion could normal alveoli be found. "Entrapped" bronchi with cartilage were not seen.

Seven cases displayed a pattern composed largely of cysts greater than 2 centimeters in diameter (Fig. 1C). These cysts (the largest seen measured 7 cm. in greatest diameter) were lined by cuboidal to low columnar epithelium. The tissue adjacent to the large cysts contained an admixture of small cysts (also lined by cuboidal epithelium), alveoli, blood vessels, and occasional bronchi or bronchioles.

The most frequent pattern (16 cases) was the intermediate type<sup>24</sup> which consisted of variable numbers of small cuboidal to columnar epithelium lined cysts (less than 1.5 cm.) separated from each other by normal appearing alveoli (Fig. 10B).

The mucosa displayed a polypoid configuration in all cases studied. The epithelium lining these polypoid structures (Fig. 10, C and D) consisted of ciliated cuboidal to columnar cells. The pseudostratified columnar epithelium, frequently described, was seen only in entrapped bronchi (Fig. 11, A and B).

Increased amounts of elastic tissue were noted in the walls of the cysts lined by the cuboidal to columnar epithelium. The elastic tissue was irregularly distributed but the polypoid structures usually displayed dense concentrations of it (Fig. 11*C*, arrows).

In no instance, however, was elastic tissue seen in an area not lined by cuboidal epithelium. Frequently an abrupt termination of elastic tissue and epithelium could be found as the cyst entered a respiratory bronchiole or alveolus (Fig. 11D, arrows).

Mucogenic cells were noted in 5 of the cases. These tall columnar cells with basal

nuclei and copious apical cytoplasm (Fig. 12) were found as isolated collections completely filling small (less than 0.2 cm.) cysts or, more frequently, as polypoid structures alternating with non-mucin producing epithelium projecting into the lumina of larger cysts.

Inflammation, while occasionally seen in areas of normal lung adjacent to the malformations, was not noted within the mal-

formation itself.

#### COMMENT AND SUMMARY

Thirty-one cases of cystic adenomatoid malformation were reviewed at the Armed Forces Institute of Pathology.

Of this group 15 had roentgenograms.

The most common roentgen pattern is that of a multicystic lucent lesion with cyst expansion and mediastinal shift. The cyst walls are usually thick with some variation and are composed of small non-expanded adenomatoid cysts, alveoli, blood vessels and atelectatic areas. These cysts commonly contain fluid at gross cutting and often demonstrate air-fluid levels on roentgenograms.

Respiratory distress is related to the degree of lung involvement and expansion of

the adenomatoid cysts.

The roentgenologist and pediatrician play a significant role in patient management through accurate diagnosis, since infant survival depends on subsequent prompt surgical removal of the affected lung tissue.

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# SUPERIOR MARGINAL RIB DEFECTS IN RESTRICTIVE LUNG DISEASE\*

By THEODORE E. KEATS, M.D. CHARLOTTESVILLE, VIRGINIA

IN 1969 Sargent and his co-workers described in detail the entity of superior marginal rib defects and enumerated the many disease states in which this phenomenon occurs.<sup>3</sup> They included an "idiopathic group" with no known associated disease.

It is the purpose of this brief report to indicate that the same process may occur in individuals with restrictive lung disease. These individuals may, in fact, represent some or all of the cases in Sargent's "idio-

pathic group."

Diffuse superior marginal cortical rib loss is most commonly recognized as an incidental finding in the collagen diseases and has been seen in rheumatoid arthritis, lupus erythematosus, scleroderma, dermatomyositis, and I have recently been shown the same changes in patients with ankylosing spondylitis.<sup>2</sup> It is best seen in the superior margins of the posterior aspects of ribs 3 to 6 (Fig. 1).

In their discussion of the etiology of this condition, Sargent *et al.*<sup>3</sup> have further developed the concept that this loss of bone is secondary to intercostal muscle atrophy with resultant loss of mechanical stress to the cortical bone of the ribs at the muscle insertions and this, in turn, results in loss of bone. Additional support of this thesis is given by Elke and Meier-Ruge, who examined such an area of rib bone loss histologically in a patient with scleroderma and were able to demonstrate only the alterations of osteoporosis. They also suggested that the bone loss was due to disturbance of dynamics and osteoporosis.

Further weight for this concept is lent by my own observations of the occurrence of similar alterations in elderly patients with restrictive lung disease, either due to interstitial pulmonary fibrosis and/or emphysema (Fig. 2). This finding would seem a logical extension of the theory of loss of mechanical stress as the etiology of this change in the ribs, since these patients' chest walls have limited excursion, second-



Fig. 1. Loss of the superior margins of the posterior ribs in a patient with scleroderma.

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Fig. 2. Loss of the superior margins of the posterior ribs in a 64 year old man with restrictive lung disease due to interstitial fibrosis.

ary to poor compliance of their lungs. Patients with collagen diseases indeed have similar restriction of movement by virtue of pulmonary involvement, or changes in the soft tissues of the chest wall itself.

Furthermore, patients with paralytic poliomyelitis and loss of muscle strength of the thoracic cage show identical changes, probably on the same basis.

It would then appear that superior marginal rib defect is a non-specific sign of intercostal muscle atrophy. Such atrophy may be due either to loss of innervation, or secondary to restriction of chest wall motion from lack of compliance of either the chest wall or the lungs.

#### CONCLUSION

Superior marginal rib defects may be seen in patients with restrictive lung disease, lending further weight to the concept that this alteration represents atrophy of bone, secondary to loss of intercostal muscular stress and subsequent atrophy of bone at the muscle insertions.

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# AN AUTOMATED TECHNIQUE FOR THE ANGIO-GRAPHIC "SPILLOVER" DETERMINATION OF BLOOD FLOW\*

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MORPHOLOGIC changes in blood vessels do not necessarily adequately reflect functional capacity.4 The capability of determining blood flow adds a significant dimension to the angiographic procedure. This is readily apparent in ischemic vascular disease and in the evaluation of the functional impairment of stenosis and the adequacy of collateral circulation. In addition, the effect of pharmacologic agents on the blood vascular pool may be more readily assessed by the added capability of being able to measure blood flow.

Roentgenographic techniques of determining blood flow include linear flow velocity studies,3,8 contrast density variation methods<sup>9,11,14</sup> and volumetric determinations.10 The "spillover" flow meter technique of measuring blood flow was introduced in 1966.12 It was subsequently adapted for an animal model,7 and more recently, applied clinically.1

The angiographic "spillover" flow meter technique of measuring blood flow is based on the concept that blood flow within an artery is equal to the injection rate of contrast material at the instant of reflux of the contrast material just proximal to the catheter tip.

The increasing rate of injection used to measure blood flow by the angiographic "spillover" techniques has been previously accomplished by a manually operated device.1

This report describes the "spillover" flow meter technique of measuring blood flow utilizing a simple automated method of increasing the rate of injection which is simultaneously recorded on the roentgenographic film during angiography.

#### MATERIAL AND METHODS

An injector (Viamonte-Hobbs) adapted to permit automatically increasing rates of injection. The specific rates were selected to encompass the expected blood flow within the vessel to be studied. Three ranges of flow were available: (1) from 1.8 to 8.0 cc./sec.; (2) from 4.5 to 14.0 cc./sec.; or (3) from 14.0 to 22.0 cc./sec. The duration of each injection delivering the contrast material through a range of flow rates was constant at 2.5 sec. A radiopaque recording dial placed on the roll film changer (Franklin) allowed roentgenographic demonstration of the increasing rate of injection. Activation of the filming program triggered the start of the injection.

The validity of the "spillover" method of measuring blood flow utilizing the automatically increasing rate of injection was evaluated in vitro, measuring water flow, and then applied to the experimental animal.

## In Vitro

A plastic tube 5 mm. I.D. and 6 mm. O.D. carrying water from a 4 foot high reservoir was taped along the top of the film changer. A screw clamp fitted to the end of the tube regulated the flow of water. A catheter (No. 5 Fr.) was inserted through the plastic tube in the direction of water flow and positioned so that the tip lay within the tube on the film changer. The cathe-

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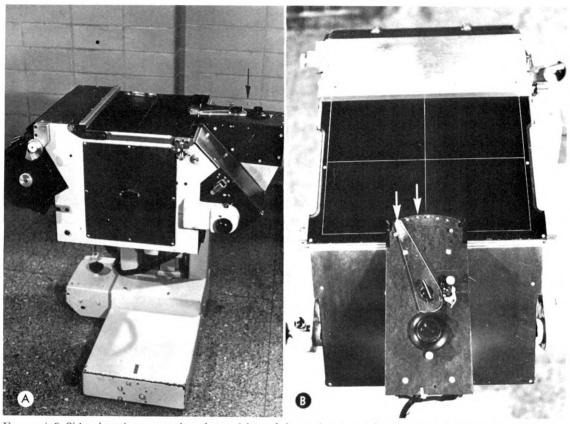


Fig. 1. (A) Side view demonstrating the position of the radiopaque injection rate dial (arrow) on the film changer. (B) Overhead view illustrating the overlapping radiopaque dial markers (arrows) on the edge of the film exposure area.

ter was then connected to the power injector.

The radiopaque dial displaying the injection rate was placed over the edge of the film changer (Fig. 1). In this way, the instantaneous rate of injection of contrast material through the catheter was recorded on the film.

The flow rate of water through the plastic tube was governed by adjusting the screw clamp. Each flow rate from 3.5 cc./sec. to 12 cc./sec. was measured at least twice using a cylinder and a stop watch. Serial roentgenograms, 4 films per second, were exposed during the increasing rate of injection of the contrast material (Renografin 76). The rate of flow by the "spillover" technique was determined by the roentgenograms demonstrating the maximum opacification of the column of contrast

material at the moment of reflux just proximal to the catheter tip (Fig. 2). The specific rate of injection of contrast material at that instant was recorded on the roent-genogram and compared to the known water flow rate.

### In Vivo

For the *in vivo* experiments, the angiographic "spillover" method of determining blood flow rates was compared to those measured by an electromagnetic flow meter.

Fourteen experiments were conducted on 6 dogs. The animals were anesthetized with Nembutal (30 mg./kg.). The vessel to be studied was surgically isolated, and a Narco electromagnetic flow probe was externally applied. The superior mesenteric, carotid and renal arteries were chosen because of

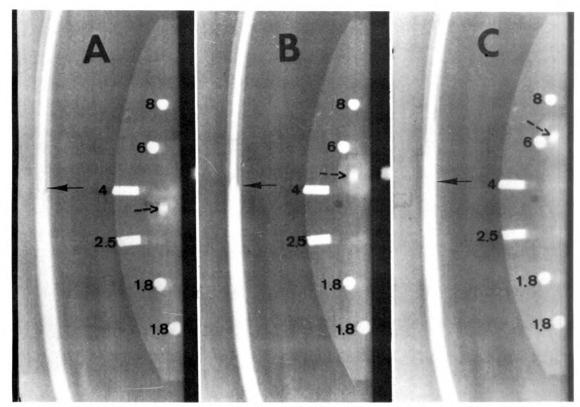


Fig. 2. (A-C) Water flow rate determination using the "spillover" flow meter. The sequential series of roent-genograms (exposed at 4 per second) demonstrate the spillover or reflux of contrast material proximal to the catheter tip (solid arrow) and the rate of contrast material injection at that instant (broken arrow). Figure 2B indicates moment of reflux. In this experiment the water flow rate was set at 5.0 ml. per second. The numbers on the dial indicate injection rate in ml. per second.

their different contour and different flow rates. The flow data were recorded on a Hewlett-Packard multichannel recorder.

A preshaped catheter (No. 5 Fr.) was passed from the femoral artery to the selected artery. The catheter tip was positioned at least 1 cm. proximal to the position of the electromagnetic flow probe. The animal was heparinized with 100 units of Na Heparin/kg.

The flow in the vessel was allowed to stabilize for 15 minutes as determined by the electromagnetic flow probe. Contrast material (Renografin 76) was injected into the vessel at an increasing rate during roentgenographic exposure of 4 films per second.

In order to study a greater range of flow within the superior mesenteric artery, blood flow was augmented in some instances prior to the "spillover" measurements. This was accomplished by the hand injection of 10 cc. of contrast material over a 5 second period prior to the actual study. The increased flow resulting from the vasodilating effect of the contrast material was detected by the electromagnetic flow probe. The angiographic "spillover" flow study was then done when the augmented flow had reached a plateau.

The serial films obtained from the above studies were reviewed independently by 5 observers. The criterion utilized to determine blood flow was that injection rate recorded on a single film which produced the maximum opacification of the column of contrast material refluxing just proximal to the catheter tip. When necessary, systolic and diastolic variations demonstrated on the roentgenograms were taken into con-

Table I

COMPARISON OF WATER FLOW RATES AS DETERMINED BY TIMED VOLUME
MEASUREMENTS AND "SPILLOVER" ANGIOGRAPHIC STUDIES

Experiment Number	Flow Rate as Determined By Timed Volume Measurements (ml./sec.)	Flow Rate as Determined by "Spillover" Angiography (ml./sec.)	Per cent Difference	
. I.	5.0	4.5	10 .	
2.	5.0	4.0	20	
3.	5.0	3.8	24	
4.	3.5	2.9	17	
5.	7.5	7.2	4	
6.	9.0	9.5	6	
7.	12.0	0.11	9	
8.	12.0	11.5	4	

sideration in the estimation of the flow values. The values determined from the roentgenograms were compared to the values determined by the electromagnetic blood flow probe immediately prior to the injection of contrast material.

#### RESULTS

#### In Vitro

The determination of water flow rates using the "spillover" angiographic method is demonstrated in Figure 2. Figure 2B demonstrates the rate of injection at the time in which the contrast material has completely filled the tube distally and begins to reflux proximal to the catheter tip. The indicated flow rate is 4.5 ml. per second, whereas the actual measurement of the flow by using the graduated cylinder and stop watch was 5.0 ml./sec. The water flow rates determined by spillover angiography and by actual measurements are presented in Table 1. The average difference in the 2 methods of measurement was 12 per cent with a range from 4 to 24 per cent. In all cases, except Number 6, the flow rates determined by reflux angiography were lower than those determined by actual time-volume measurement. The reason for this observation was not apparent.

#### In Vino

The "spillover" angiographic technique of measuring blood flow in vivo is illustrated

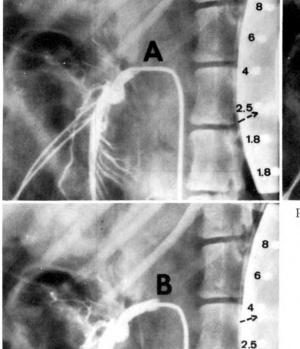
in Figure 3. The moment of contrast "spillover" or reflux is shown in Figure 3B which demonstrated maximum opacification of the vessel and the contrast material refluxing just proximal to the catheter tip.

The values obtained by the reviewers are averaged for each determination and compared to the electromagnetic flow probe values (Table II). The average difference for all experiments is 13 per cent.

#### DISCUSSION

The automated device described in this report allows for an increasing rate of injection of contrast material over a specific time interval. Automation of this capability minimizes possible variability created by manually operated injections. The instantaneous rate of injection is recorded on the roentgenogram during angiography. This apparatus is readily adapted to most film changers. The availability of such a device enhances the scope and feasibility of the "spillover" technique.

The validity of the reflux or "spillover" technique has been tested against an *in vitro* measurement of water flow and the electromagnetic flow meter *in vivo*. An average difference between the measurements of 11 per cent was found *in vitro* and 13 per cent in the *in vivo* animal experiments. These finding are similar to those reported by other investigators utilizing the "spillover" technique.<sup>1</sup>



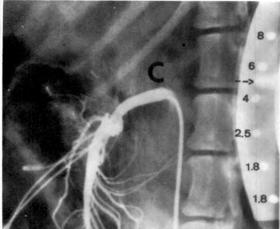


Fig. 3. (A-C) Sequential series of roentgenograms (exposed at 4 per second) of the blood flow determination in the canine superior mesenteric artery. Figure 3A illustrates filling of the vessel immediately prior to reflux. Figure 3B demonstrates maximum opacification of the column of contrast material refluxing proximal to the catheter tip. In Figure 3C, the injection rate greatly exceeds the blood flow and contrast material is seen refluxing into the aorta. In this experiment, roentgenogram 3B was chosen to indicate the rate of blood flow. The electromagnetic flow meter reading of the blood flow immediately prior to "spillover" determination was 3.6 ml./sec. The five reviewers using the spillover technique estimated flow at 3.8, 4.0, 5.0, 3.6 and 3.5.

The broken arrow indicates the injection rate for each exposure. The numbers on the dial indicate injection rate in ml. per second.

1.8

The criteria employed in the determination of the flow rate by the "spillover" method are dependent upon 2 factors: (1) the detection of maximum density in the artery; and (2) the instant of reflux. Maximum density of the contrast material can be determined densitometrically. The criterion fraught with subjective interpretation is the definition of the instant of reflux.

Errors may result from layering of the contrast agent in that reflux may be more apparent than real. Turbulence is especially troublesome at very low or very high flow rates. The effect of turbulence may be minimized by avoiding any restriction of the lumen of the catheter. For best results the tip of the catheter should be positioned in mid-stream.

The roentgenographic sequence may yield an insufficient number of films exposed per second. The instant of reflux may not be captured. Cineroentgenography of the continuous events is more ideal in that systolic as well as diastolic reflux are more likely to be recorded. The rate of blood flow would be the average of these values. The advantage of cineroentgenography is offset by the inferior display of morphology necessitating multiple injections.

The vasoactive effects of the contrast material must also be considered in blood flow measurements. Contrast material may temporarily increase the blood flow in most vascular beds.<sup>2,6,15</sup> In the renal vascular bed, radiopaque contrast material is reported to initially produce vasodilatation

TABLE II COMPARISON OF IN VIVO, CANINE BLOOD FLOW RATES DETERMINED BY ELECTROMAGNETIC FLOWMETRY AND "SPILLOVER" ANGIOGRAPHY

Experi- ment Number	Vessel	Blood Flow Rate as Determined from E.F.M.*	Flow Rate (ml./sec.) as Determined From "Spillover" Angiography by 5 Reviewers						
		(ml./sec.)	I	2	3	4	5	Average	
I.	Carotid	2.8	3.5	3.3	3.3	3.3	3.0	3.3	
2.	Carotid	3.0	3.4	4.0	4.0	3.6	3.6	3.7	
3.	Renal	3.6	3.0	4.0	3.0	3.3	3.0	3.3	
4.	Renal	3.3	2.5	, 4.0	4.0	2.5	3.0	3.2	
5.	SMA†	10.4	11.0	10.0	10.5	10.0	9. <b>3</b>	10.2	
6.	SMA	4.8	3.3	3.4	4.0	3.6	3.3	3.5	
7.	SMA	6.6	6.0	7.8	7.1	4.5	7.0	6.5	
8.	SMA	3.6	3.8	4.0	5.0	3.6	3.5	4.0	
9.	SMA	10.3	8.8	9.5	5.3	9.0	9.0	8.3	
10.	SMA	5.2	6.0	5 - 5	6.0	7.0	5.8	6. r	
II.	SMA	9.8	9.0	9.5	9.7	9.0	9.9	9.4	
12.	SMA	11.3	9.2	9.5	10.0	9.0	10.6	9.7	
13.	SMA	5.3	6.0	7.0	6.0	6.0	5.8	6.2	
14.	SMA	5.4	5.5	5.5	4.5	4.0	5.3	5.0	

<sup>\*</sup> E.F.M. = Electromagnetic Flow Meter. † SMA = Superior Mesenteric Artery.

followed by a more prolonged vasoconstriction.<sup>5,13</sup> This alteration in flow usually occurs about 20 seconds after the injection of even 4-5 cc. of contrast material used for checking the position of the catheter and persists for approximately 1-3 minutes depending upon the amount of contrast material used. For this reason, blood flow measurements using the "spillover" technique should not be attempted for at least 5 minutes after test dose of contrast material usually used for localization. The contrast material used for the actual blood flow determination does not affect the value of the measurements because any vasoactive effect occurs after the examination is complete.

The accuracy of the reflux method in vivo, a difference of 13 per cent from electromagnetic flow values, is sufficient for most clinical situations where information is necessary concerning altered blood flow.

#### SUMMARY

An automated method of increasing the

angiographic "spillover" blood flow measurement studies is presented.

The technique described is readily adaptable to the angiographic examination and allows for automatic recording on the angiographic film of the increasing rate of contrast medium injection.

The method was tested to measure both water flow rates and blood flow in vivo in dogs.

The results indicate that the blood flow measurements are sufficiently accurate for use in most clinical situations where an altered blood flow is suspected.

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## DIAGNOSIS OF DISSECTING AORTIC ANEURYSM BY LEFT ATRIAL ANGIOGRAPHY\*

By ITZHAK KRONZON, M.D., PAUL G. DEUTSCH, M.D., RICHARD LEFLEUR, M.D., and EPHRAIM GLASSMAN, M.D.

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THE diagnosis of dissecting aortic aneurysm is made in most instances using a transaxillary or transfemoral approach to retrograde aortography.<sup>2,4,5</sup> Employing this technique, entry into the false lumen may occur, in which case injection of a large bolus of dye may be hazardous.<sup>4</sup> Furthermore, passage of the catheter into the false lumen will prevent its advancement into the left ventricle for the purpose of obtaining hemodynamic measurements.

Two cases are reported in which retrograde aortography was inadequate, and the study was completed by dye injection into the left atrium and left ventricle after passage of the catheter across the atrial septum.

#### REPORT OF CASES

CASE I. M.M., a 60 year old female, was admitted to New York University Hospital with symptoms and physical findings highly suggestive of aortic dissection and aortic valvular regurgitation. The ascending aorta was dilated on the chest roentgenogram. A Judkins pigtail catheter was advanced from the femoral artery to the ascending aorta, but could not be passed into the left ventricle. The suspicion that the catheter had entered the false lumen was confirmed by injection of a small amount of contrast medium. Transseptal left atrial catheterization was then performed by a modified Brockenbrough technique.1 Left ventricular cineangiography was then performed and an intimal flap was visualized from the point of tear in the aortic root above the right coronary cusp to the mid portion of the aortic arch, creating an anterior false lumen (Fig. 1). The opaque medium in the false lumen had not cleared 30 sec. after the injection.

CASE II. M.S., a 53 year old male, was admitted to Bellevue Hospital with signs and

symptoms of aortic dissection. Aortography was attempted by a right percutaneous transaxillary approach, but it was not possible to pass the catheter into the aortic root. Injection of radiopaque medium into the right subclavian artery (Fig. 2A) showed anomalous origin of both carotid and both subclavian arteries from a common left brachiocephalic trunk. During preparation for pulmonary angiography the catheter passed through a patent foramen ovale into the left atrium (Fig. 2B). Left atrial angiography demonstrated an intimal flap starting at the aortic root and extending into the descending aorta. Both true and false lumens could be easily distinguished, and compression of the former was noted. These findings were confirmed at surgery performed the same day.

#### DISCUSSION

Retrograde aortography by the percutaneous femoral or right transaxillary approach is the procedure of choice for demonstration of aortic dissection.<sup>5</sup> Using these methods it may not be possible to avoid entering the false lumen of the dissection. The risk of extending the dissection in the aorta or its branches, and further compromising the circulation due to injection of dye into the false lumen, has been stressed.3 In such instances where catheterization of the true lumen cannot be accomplished, either pulmonary arterial or left atrial angiography may be attempted. In our 2 patients, the complete extent of the dissection could not be determined by the usual retrograde method. Furthermore, necessary hemodynamic data were unobtainable in Case I, a patient with clinically significant aortic regurgitation. Left atrial catheterization permitted completion of the studies in these patients, and provided access to the left ventricle for assessing hemodynamic

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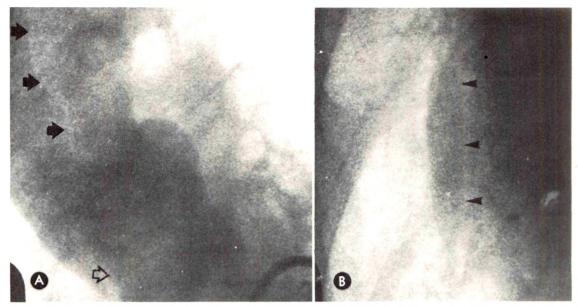


Fig. 1. Case 1. (A) Left ventricular injection via a transseptal catheter (left anterior oblique projection). Note intimal tear just distal to the origin of the right coronary artery (white arrow), and intimal flap separating the false lumen anteriorly from the true lumen (black arrows). (B) Thirty seconds later—dye still opacifying the false lumen (arrows).

function. Recognizing the hazards of retrograde aortography, Hart *et al.*<sup>3</sup> suggested the use of a transseptal route. To the best of our knowledge the application of this

suggestion has not been reported previously.

Although transseptal puncture is generally a safe and frequently utilized method

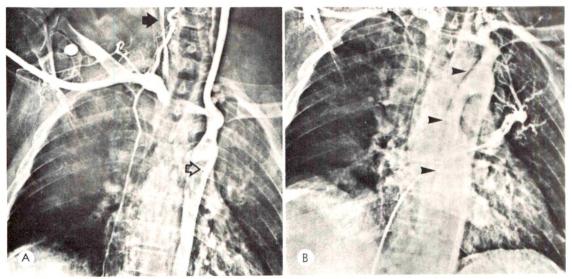


Fig. 2. Case II. (A) Right subclavian injection demonstrates anomalous origin of both subclavian and carotid arteries from a common left brachiocephalic trunk. There is no distal filling of the left subclavian artery. Note intimal flap in the descending aorta (white arrow), and a linear defect suggestive of dissection in the right carotid artery (black arrow). The ascending aorta and the proximal extension of the dissection cannot be visualized. (B) Left atrial injection. Note aortic dissection extending proximally to the aortic root (arrows). The true lumen of the descending aorta appears compressed and narrow.

for left heart catheterization, the increased hazard of the technique in the presence of aortic root dilatation is well recognized. Obviously, it is recommended that only those physicians who are experienced in the routine use of the method employ it in such critically ill patients.

#### SUMMARY

Two cases of dissecting aneurysm of the aorta are described in which retrograde aortography was inadequate either because of passage of the catheter into the false lumen or by anomalous origin of the brachiocephalic arteries. In both cases the studies were completed by left atrial catheterization. In both patients the entire extent of the dissection in the aortic root was determined. It is suggested that a transseptal approach be employed only in those cases in which the study cannot be completed by the retrograde technique, and that it be used only by those skilled in this specialized approach.

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# PULMONARY ARTERIAL HYPERTENSION IN PROGRESSIVE SYSTEMIC SCLEROSIS\*

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and PETER M. KELLY, M.D.§
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VER the past 2 years, the authors have encountered several cases of roentgenologically evident pulmonary arterial hypertension (PAH), occurring in conjunction with progressive systemic sclerosis (PSS; scleroderma). Although a review of the medical literature revealed earlier reports of this association, 1-5,7-11 no report devoted to the occurrence of pulmonary arterial hypertension in PSS was encountered in the English language radiological literature. Having been impressed by what seemed a relatively frequent occurrence of chest roentgenographic changes reflecting pulmonary hypertension in PSS, we have reviewed all of the cases of clinically and/or pathologically established PSS seen over the past 10 years at this institution on which complete medical records and chest roentgenograms were available. A total of 41 cases of systemic sclerosis met the standards for this review, the results of which will be presented here.

#### CRITERIA AND METHODS

Only cases with a pathologic (biopsy and/or autopsy) diagnosis or unequivocal clinical findings of PSS were included in this review. Several cases of apparent systemic sclerosis presented a symptom complex which was nonspecific, suggesting the possibility of another collagen disorder such as rheumatoid or systemic lupus erythematosus variants; these were excluded from the final analysis. For purposes of estimating the frequency of occurrence of roentgenographic pulmonary arterial hypertension, cases were also excluded if there were any

clinical, roentgenographic, or pathologic evidence of another pulmonary parenchymal or vascular disease (i.e., emphysema or pulmonary embolism). Only those cases having posteroanterior and lateral chest roentgenograms of good quality following the establishment of the diagnosis of PSS were included in the review, and in most instances multiple chest studies were available. The primary roentgenographic criteria employed for the diagnosis of PAH included enlargement of the main pulmonary artery segment or pulmonary outflow tract, and unequivocal enlargement of both right and left main pulmonary arteries; secondary criteria included rapid peripheral tapering of pulmonary arterial branches and signs of right ventricular enlargement. Finally, the medical records were surveyed for clinical evidence of PAH (i.e., increased pulmonic component of the second heart sound, a widely split or fixed split second heart sound, right ventricular heave, electrocardiographic evidence of right ventricular hypertrophy, etc.).

#### RESULTS

Of the 41 cases of established PSS meeting the standards set forth for this review (see above), 3 showed unequivocal evidence of PAH on all chest roentgenograms that were available, and an additional 2 cases had chest roentgenographic findings which were highly indicative of PAH. In this series, therefore, chest roentgenograms on approximately 12 per cent (5 of 41) of the cases reviewed showed definite or probable roentgenographic evidence of PAH

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following a diagnosis of progressive systemic sclerosis. Although minimal-to-moderate interstitial fibrosis was evident in the "positive" cases, the apparent severity of pulmonary arterial hypertension noted roentgenographically and/or pathologically was out of proportion to the degree and extent of the interstitial lung disease. Unfortunately, in this retrospective series of 41 patients, pressure measurements by cardiac catheterization and pulmonary function studies were performed infrequently; therefore, an effective correlation of these parameters with the roentgenologic findings is not possible with the available data.

In an additional 8 patients in this review, clinical findings (usually an increased pulmonic second sound) were consistent with PAH; pulmonary vascular changes at autopsy suggested the presence of pulmonary arterial hypertension in another 2 patients. Therefore, of the 41 cases reviewed, 15 cases (37 per cent) might be inferred to have had PAH by roentgenologic, clinical, and/or pathologic criteria (Table 1). More sophisticated studies, including cardiac and pulmonary artery catheterization in "subclinical" cases, might conceivably have revealed further instances of early PAH, had the studies been performed.

#### REPORT OF CASES

Case reports on 2 patients with chest roentgenographic findings diagnostic of

Table I
INCIDENCE OF PAH IN CASES OF PROGRESSIVE
SYSTEMIC SCLEROSIS
(41 CASES)

Cases without evidence of pulmonary	
arterial hypertension (PAH):	26 (63%)
Cases with evidence of PAH:	
Roentgenographic (definite)	3
Roentgenographic (probable)	2
Clinical (see text)	8
Autopsy	2
	B
	15 (37%)

pulmonary arterial hypertension are presented briefly here.

CASE 1. N.P. This 33 year old female was first admitted to UCLA in August 1970 with a history of Raynaud's phenomenon and progressive acrosclerosis for 3 years. In December 1969 she had undergone a bilateral cervical sympathectomy for ulceration of the "right knuckles." Since then she had noted the insidious onset of dyspnea on exertion, mild dysphagia, and arthralgias of the knees and ankles. Physical examination revealed indurated, shiny, hyperpigmented skin over the hands and both forearms, and superficial ulcerations were noted dorsally over several of the proximal interphalangeal joints bilaterally. Limitation of motion of all joints of the hands and wrists was also described. The examination was otherwise unremarkable. She was normotensive and her electrocardiogram was normal. An upper gastrointestinal series and small bowel followthrough revealed lack of normal peristalsis in the esophagus, consistent with scleroderma.

The patient was seen in the clinic on June 1971 with a continuing complaint of moderate shortness of breath on exertion, which has continued until the present time. Physical examination revealed a widely split second heart sound with the pulmonic component greater than the aortic, and few bibasilar rales. Pulmonary function tests in June 1973 indicated combined mild-to-moderate restrictive and obstructive defects with normal airway resistance and markedly abnormal diffusing capacity. The patient is currently being followed in the UCLA clinics. A recent chest roentgenogram is shown in Figure 1, A and B.

CASE II. N.B. This 45 year old female was first admitted to UCLA in September 1968 with a 9 month history of increasing dyspnea on exertion. She gave a 25 year history of Raynaud's phenomenon, and physical examination revealed thickened skin over the fingers, hands, toes, and feet. There were multiple telangiectases over the face and upper trunk. Blood pressure was 110/70 mm. Hg. The lungs were normal except for an apparent inability by the patient to take a very deep breath. The second heart sound was widely split, with accentuation of the pulmonic component. The examination was otherwise unremarkable. Electrocardiogram showed right ventricular hypertrophy. A cine-esophagogram and upper gastrointestinal

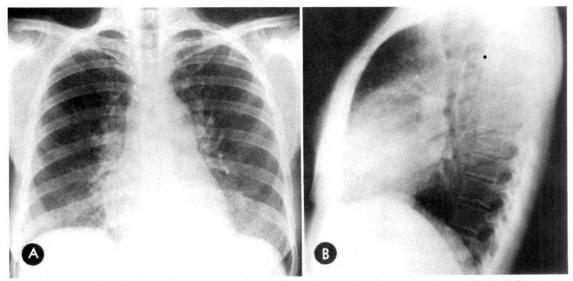


Fig. 1. Case I. (A and B) Posteroanterior and lateral chest roentgenograms give evidence of prior right sympathectomy for Raynaud's phenomenon. In addition, the main pulmonary artery, as well as the right and left pulmonary arteries, are enlarged, with rapid tapering of branch vessels, consistent with pulmonary arterial hypertension. The outflow tract of right ventricle is also prominent on the lateral view.

series did not reveal any abnormality. Roentgenograms of the hands showed calcinosis with slight resorption of several of the distal phalanges of the left hand. A punch biopsy of the skin of the left hand was consistent with scleroderma. Resting arterial blood gas analysis showed pH 7.51, pO<sub>2</sub> 66 mm. Hg and pCO<sub>2</sub> 27. Pulmonary function tests indicated moderately severe obstructive ventilatory insufficiency. A lung scan demonstrated multiple ill-defined perfusion defects bilaterally. Pulmonary arteriography was performed and revealed a main pulmonary artery pressure of 140-160/60 mm. Hg, RV pressure of 160/10, and RA pressure of 10/3. A left upper branch pulmonary artery injection failed to demonstrate any emboli. Finally, an open lingular lung biopsy showed diffuse pulmonary fibrosis and acute vasculitis consistent with scleroderma. A representative chest roentgenogram is shown in Figure 2, A

The patient was discharged with the diagnosis of "CRST syndrome" (calcinosis, Raynaud's, sclerodactyly, and telangiectasia), scleroderma lung disease and pulmonary hypertension. She was seen in clinic following discharge where medications included digitalis, diuretics, steroids, and anticoagulants. In May 1969 she was admitted with increasing orthopnea and wheezing, and shortly thereafter she experienced a cardiac arrest.

Postmortem examination revealed severe sclerosis of both the pulmonary arteries and the veins, as well as right ventricular hypertrophy and dilatation. Microscopically, there was dense hyalinized fibrous tissue in the dermis and throughout the submucosa of the gastrointestinal tract, consistent with scleroderma. In addition, there was mild, scattered interstitial fibrous thickening of the pulmonary alveolar septa. Mild-to-moderate intimal thickening was present in large and small pulmonary arteries as well as in the veins, with occasional occlusion of smaller vessels by intimal proliferation.

#### DISCUSSION

In a retrospective review of 41 patients with established PSS, and with chest roent-genograms and complete clinical records available, 3 definite and 2 highly probable cases of pulmonary arterial hypertension were observed roentgenographically. The degree of PAH was out of proportion to the severity of the interstitial pulmonary disease attributable to systemic sclerosis. Similarly, a review of the non-radiologic literature revealed reported cases with pulmonary arteriolar changes of pulmonary hypertension at autopsy that were associated with minimal-to-absent fibrotic in-

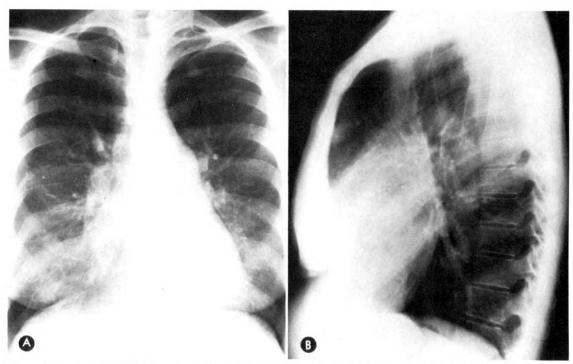


Fig. 2. Case II. (A and B) There is moderate pectus deformity. Nevertheless, arterial changes similar to those in Case I are present and are diagnostic of pulmonary arterial hypertension (confirmed at autopsy). As in Case I, roentgenologic evidence of interstitial pulmonary fibrosis is minimal.

terstitial changes in the corresponding lung.<sup>1,2,5,7,9,11</sup>

Although searched for, no correlation between the presence of Raynaud's phenomenon and the presence of clinical and/or roentgenological evidence of PAH was observed in our series. However, a possible correlation between the severity of Raynaud's phenomenon and the presence or severity of PAH cannot be excluded in this retrospective study, because neither the severity of Raynaud's phenomenon nor the level of pulmonary arterial hypertension were quantified. The possibility that systemic sclerosis is in fact a disease primarily affecting the microcirculation of many organs (including the skin, lung, and kidney) has been discussed in a recent review.6 The relatively high incidence of PAH observed on chest roentgenograms in this series raises the possibility of an even higher occurrence of subclinical pulmonary vascular involvement in this disease, without roentgenologic or clinical manifestations. This possibility

should now be subjected to a prospective study, possibly with the use of Swan-Ganz catheter measurements of pulmonary artery pressure, including PSS patients who are asymptomatic for lung or pulmonary vascular involvement. Data of prognostic significance in the individual patient, as well as of basic pathogenetic significance for the disease process, might be obtained by this means.

In view of the unexpectedly high incidence (12 per cent) of definite or probable changes of PAH on chest roentgenograms in this series of 41 patients with PSS, it would also seem incumbent upon the radiologist to search for PAH in known cases of PSS and to suggest the possibility of systemic sclerosis in the differential diagnosis of roentgenologically evident "idiopathic" pulmonary hypertension.

#### SUMMARY

Forty-one cases of progressive systemic sclerosis were reviewed retrospectively in

order to ascertain the frequency of roentgenographic pulmonary arterial hypertension (PAH) in progressive systemic sclerosis (PSS).

Chest roentgenograms on 12 per cent (5 of 41) of the cases reviewed showed definite or probable roentgenographic evidence of pulmonary arterial hypertension, and a total of 15 (37 per cent) might be inferred to have had pulmonary arterial hypertension by recorded roentgenographic, clinical, and/or pathologic criteria. The degree of pulmonary arterial hypertension was out of proportion to the severity of interstitial pulmonary disease attributable to scleroderma. Moreover, no correlation between the presence or recorded severity of Raynaud's phe iomenon and the presence of clinical and/or roentgenographic evidence of pulmonary arterial hypertension was observed. Radiologists should be aware of the possibility of pulmonary arterial hypertension in known cases of progressive systemic sclerosis; in addition, they should be prepared to raise the possibility of this association in the differential diagnosis of roentgenographically evident "idiopathic" pulmonary arterial hypertension.

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# UPPER LOBE FIBROSIS IN ANKYLOSING SPONDYLITIS\*

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ANKYLOSING spondylitis, like other connective tissue disorders, is a multisystem disease. It is already recognized that there is a higher incidence of iritis, ulcerative colitis, aortitis, arteritis, and cardiomyopathy<sup>18</sup> in these cases. A less well known extraskeletal expression of this disease is a characteristic form of upper lobe fibrosis, which differs significantly from the changes associated with other collagen diseases.

Upper lobe fibrosis has now been reported in over 60 patients, and there has been striking similarity in the roentgenographic changes in all of the reported cases.

This is the first report of this entity in the radiologic literature and includes 2 previously unreported patients.

#### MATERIAL AND METHOD

We have reviewed the records of 103 patients from the University of Michigan Medical Center and the Ann Arbor Veterans Administration Hospital, all of whom had typical roentgenographic skeletal manifestations of ankylosing spondylitis involving primarily the lumbosacral and thoracic spine. Fifty-two patients were selected for inclusion on the basis of adequacy of clinical records and availability of chest roentgenograms. Among these, 21 had documented disease less than 10 years; however, their initial spine roentgenograms showed advanced disease. Since a few of the previously reported cases developed upper lobe fibrosis within the first few years after onset, including I within only a few months, we elected to include these 21 patients.

The records of patients with apical losing spondylitis.

fibrosis were reviewed for evidence of previous active infection or positive skin or serologic tests for tuberculosis or fungi. Previous pyogenic pneumonia or lung abscess was excluded as a cause for residual fibrosis.

#### RESULTS

There were 31 patients who had ankylosing spondylitis 10 years or longer; in 21 patients the disease had been present less than 10 years. Unexplained upper lung zone fibrosis was found in 2 of the 52 patients. Four of the patients had chronic, stable, apical pulmonary changes known to be secondary to inactive tuberculosis. None had infections with atypical mycobacteria, but one of the patients with upper lobe fibrosis developed an Aspergillus mycetoma. The chest roentgenograms in 2 additional patients demonstrated costophrenic blunting secondary to previous episodes of pleuritis.

One of the patients with apical fibrosis was shown to develop a roentgenographically abnormal lung apex o years after the diagnosis of spondylitis. The second patient was first recognized as having pulmonary fibrosis following 20 years of spondylitic arthritis; the exact duration of the pulmonary disease could not be documented because chest roentgenograms done at an outside hospital had been destroyed after 5 years. The pulmonary symptoms experienced by the 2 patients with lung involvement were quite dissimilar. The case histories are briefly presented because they illustrate the 2 extremes of fibrotic pulmonary disease occurring with anky-

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#### REPORT OF CASES

Case I. A 19 year old male developed lumbar pain in March 1959. The onset of his ankylosing spondylitis was explosive and its progression rapid; typical roentgenographic findings were present in the sacroiliac joints and lumbar spine 3 months after he first sought medical attention. Cervical spine, hip, and shoulder involvement ensued and the patient was confined to a wheelchair.

In 1967, 9 years after the onset of the spondylitis, a routine hospital admission chest roentgenogram showed the first localized fibrolinear abnormality in the upper lobe of the left lung. A tomogram of the area of disease is shown in Figure 1. Skin tests, serologic tests, and multiple sputum examinations for fungi and tuberculosis were negative.

Six months before the onset of his spondylitis at age 19, the patient had undergone resection of the lower lobe of the left lung because minimal cylindrical bronchial dilatation noted on a bronchogram obtained soon after treatment of a neglected pyogenic pneumonia had been interpreted as showing bronchiectasis. The 1959 bronchograms of the left upper lobe and right lung were normal. Chest roentgenograms in the intervening 9 years had shown minor postoperative changes confined to left lower thorax; no other pulmonary abnormalities had been present.

By December, 1970 his chest roentgenogram showed dest uction of the remaining left upper lobe complicated by mycetoma formation (Fig. 2). A selective left upper lobe bronchogram was obtained (Fig. 3), and demonstration of saccular bronchiectasis led to an extrapleural left upper lobectomy.

Microscopic examination of the surgical specimen showed the lung parenchyma to be destroyed by interstitial fibrosis. A few recognizable alveoli showed thickened septa. Chronic inflammatory cells were prominent. One ectatic bronchial radicle contained a mass of fungi with the morphology of *Aspergillus* (Fig. 4). Smears and cultures from the specimen were otherwise negative.

The patient is now free of pulmonary symptoms, but has developed a small ominous area of fibrosis with some volume loss in the apex of the right lung. The abnormality resembles that first seen in the left lung, but no progression has occurred between May 1971 and May 1974 (Fig. 5). Studies of the sputum for pathogens remain negative.



Fig. 1. Case 1. This tomogram section of the first fibrocystic abnormality in the upper lobe of the left lung was taken 9 years after the diagnosis of ankylosing spondylitis and 3 years before the patient developed pulmonary symptoms.

Case II. A 47 year old male was admitted to the hospital in June, 1970, for re-evaluation of therapy for ankylosing spondylitis present for 28 years. The patient had first noted gradual onset of dorsal-lumbar pain in 1942, but had not sought medical attention until 1950. The disease progressed with involvement of the spine, hips, and shoulders.

The routine admission chest roentgenogram showed a circumscribed area of fibrolinear abnormality in the apical segment of the upper lobe of the right lung. One tomogram of the area is shown in Figure 6. The patient had smoked one package of cigarettes daily for 30 years, but denied prior pulmonary symptoms. He complained of the recent onset of cough with clear sputum production. The skin and serologic tests were negative and no fungi or mycobacteria were isolated from the sputum. The chest roentgenogram 4 years later shows no progression of fibrosis and the patient is free of pulmonary symptoms.

#### DISCUSSION

Hamilton,<sup>13</sup> in 1949, reported the first 2 patients with ankylosing spondylitis and upper lobe fibrosis which roentgenographi-

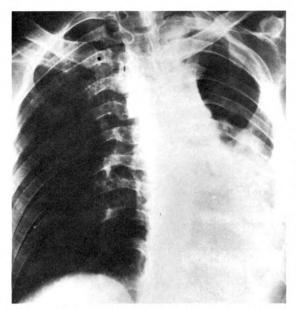


Fig. 2. Case I. The chest roentgenogram taken 3 years after the appearance of fibrotic change in the upper lobe of the left lung showed partial left upper lobe collapse. The spheroidal density in the left midlung field was a mycetoma in the pleural space. Unchanged pleural scarring had been present in the left lung field for II years and was produced by the patient's left lower lobe resection. No free pleural fluid was present.

cally resembled tuberculosis. However, in both cases *M. tuberculosis* was eliminated as a causative factor. It was well accepted that ankylosing spondylitis caused significant thoracic rigidity due especially to costovertebral joint involvement. Hamilton concluded that impaired respiratory mechanics and, particularly, ineffective cough mechanism predisposed these patients to repeated nonspecific infection which, in some cases, produced upper lobe fibrosis.

Since this initial report, over 60 additional patients have been described.<sup>1,3-6,8,9,11-13,15-19</sup> In none of these was there evidence that infection was the basis for the upper lobe fibrosis. Campbell and MacDonald,<sup>4</sup> in their report of 6 cases in 1965, were the first to suggest that the fibrosis might be a part of the pathologic process of ankylosing spondylitis.

Zorab,<sup>20</sup> in 1962, reported a comprehensive study of 88 patients with anky-

losing spondylitis. Included were postmortem studies of the lungs of 8 patients with severe, long standing changes. He concluded that the lungs are essentially healthy and not commonly the site of recurrent infections or collapse. This is essentially the same conclusion reached by Hart et al.14 in a review of 360 patients. They found no undue incidence of tuberculosis or other pulmonary infections. Court Brown and Doll<sup>7</sup> studied causes of death in 14,554 patients who had been irradiated for ankylosing spondylitis and found mortalities of 2.5-2.9 times expected from tuberculosis, pneumonia, and other respiratory diseases. However, these figures were obtained from a retrospective study of death certificates. Since the upper lobe disease



Fig. 3. Case I. The selective bronchogram of the upper lobe of the left lung showed saccular bronchiectasis to have developed in the area of asymptomatic apical fibrocystic change present 3 years earlier. A bronchogram of the same area done 6 months before the onset of the patient's ankylosing spondylitis had been completely normal.

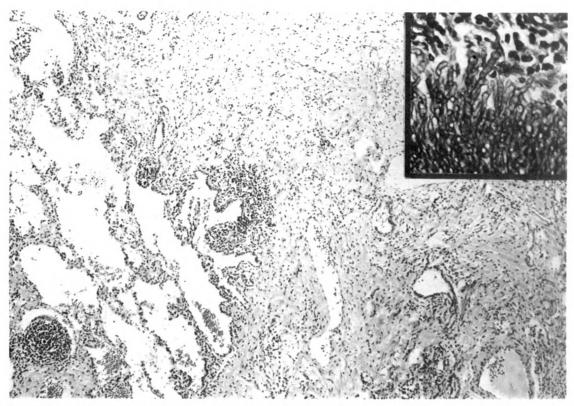


Fig. 4. Case I. The resected left upper lobe specimen showed marked interstitial fibrosis with cuboidal change in the alveolar epithelium (70.5×). In areas collagen was abundant in dense bundles that completely obliterated alveolar spaces. In other areas irregular spaces were noted but septa were thickened and fibrotic. Aggregates of lymphocytes were prominent and numerous. A few plasma cells and mononuclear histiocytes were seen. The inset shows one of the colonies of Aspergillus which was present within some of the fibrotic areas. They were associated with necrosis and acute inflammatory cell infiltration and appeared to be superimposed on the more widespread chronic changes of fibrosis (350×).

described here is clinically and roentgenographically similar to tuberculosis, it is inevitable that it has been mislabelled frequently. Six of Jessamine's<sup>15</sup> 7 patients were initially referred to sanatoria and Court Brown and Doll indicate that some of the deaths attributed to tuberculosis and other infections may include some with upper lobe fibrosis due to the primary pathologic process.

The roentgenographic findings early in the process are described as apical infiltrates consisting of small nodular and linear shadows. Coalescence and progression lead to larger opacities and cavitation often develops. The process frequently is unilateral at onset, but most often becomes bilateral; however, asymmetry may persist.

Progression of the disease is typical, although absence of any progression has been reported. As the disease extends it usually involves the upper third to upper half of the lung with involvement of the lower half very unusual.

As in other causes of cavitary disease, Aspergillus mycetomata are reported with some regularity. 1,3,5,16,17 According to Davies the incidence is somewhat higher than in post-tuberculosis cavities and others 16,17 have reported an unusual coincidence of these 2 diseases. Another secondary infection is Group IV mycobacteria. Gacad and co-workers 11,12 recently reported 2 patients with this complication, but they clearly indicate that it had no role in producing the upper lobe disease.

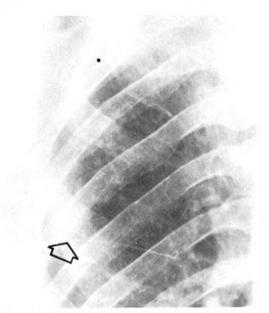


Fig. 5. Case I. The chest roentgenogram taken 6 months after resection of the upper lobe of the left lung showed fibrosis developing in the upper lobe of the right lung. Early volume loss was indicated by some upward retraction of the minor fissure.

Examinations of pathologic specimens have all indicated a rather non-specific appearance of fibrosis and infiltration with chronic inflammatory cells, primarily lymphocytes. Milder cases have shown interalveolar fibrosis, while advanced cases showed fibrosis, dilated bronchi, thin-walled bullae, and cavities.

Management of these patients is quite difficult as there is no known effective treatment. Surgical intervention carries a high operative morbidity, as several patients are reported to have developed postoperative broncho-pleural fistula or empyema. 9,15 One reported case required thoracoplasty following pneumonectomy. Case I in this report had many of these same complications. It has been suggested that severe bleeding from an aspergilloma may be the only indication for surgery. 8

#### CONCLUSION

Upper lobe fibrosis as a complication of ankylosing spondylitis has never previ-

ously been reported in the radiologic literature.

There is now evidence that patients with spondylitis are liable to develop a recognizable form of lung disease. It involves the upper part of the lungs and is characterized by consolidation and fibrosis which usually progress and frequently produce cavitation. Radiologists should be aware of this condition, for raising it as a diagnostic possibility may prevent unnecessarily prolonged investigations to exclude infectious granulomatous diseases.

The incidence must be quite low as less than 70 patients have been reported, and in our series of 52 patients only 2 had upper lobe fibrosis. Therefore, caution should still be exercised so that tuberculosis or fungal infections do not go untreated.

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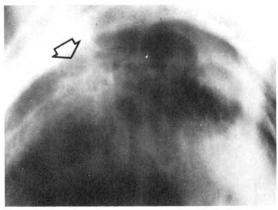


Fig. 6. Case 11. This tomogram section illustrates early fibrocystic changes in the apex of the right lung which first appeared 20 years after the onset of ankylosing spondylitis at a time when the patient first began to experience cough and sputum production.

the pathology specimens from Case 1. We would also like to thank Dr. Harvey Neiman for his help in the initial stage of this paper.

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# RETROGRADE ANGIOGRAPHY OF THE HUMAN THORACIC DUCT\*

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THE thoracic duct between the cisterna chyli and the subclavian vein is very difficult to visualize by means of usual lymphography from the lower limbs. The need, however, for a method to examine the lymph vessels in that region is a necessity, since mediastinal and thoracic processes can possibly influence the thoracic duct and its tributaries. The commonly used radiographic techniques (plain film roentgenography, tomography, angiography, etc.) are of course very helpful, but the technique of thoracic duct lymphography is lacking.

We have tried a retrograde injection of contrast medium into the thoracic duct and the results are reported.

#### MATERIAL AND METHOD

The 6 patients investigated were selected from material in which the ductus thoracicus was cannulated in order to examine the cell contents of the lymph fluid. All the patients had advanced malignancies. Two of them had carcinoma of the breast, one with metastatic lymph nodes on the right side of the neck, the other with extensive skeletal metastatic spread. One patient had a carcinoma of the right upper lobe of the lung, one had carcinoma of the bladder, another carcinoma of the rectum and one malignant melanoma. With the exception of the patient with carcinoma of the lung, no pulmonary or mediastinal metastases were demonstrated.

#### OPERATIVE TECHNIQUE

The thoracic duct was exposed through a short incision parallel to the clavicle in the

left supraclavicular fossa. After dissection, the duct was cannulated with a polyethylene catheter, PP 160, ID/OD 1.14/1.57 mm., which was fastened with ligatures. The entrance or entrances of the thoracic duct into the subclavian vein was ligated to prevent leakage of blood.

## ROENTGENOLOGIC EXAMINATION TECHNIQUE

The examination was performed I to 2 days after operation on a tiltable table under fluoroscopic control. First, water soluble contrast medium (Isopaque Cerebral, Nyco, Norway) was injected slowly by hand during fluoroscopy. The patient was moved from supine to half-erect and erect position and back several times. Valsalva maneuvers and different respiratory phases were used. Roentgenograms were obtained under fluoroscopic control. The radiopaque contents of the thoracic duct were partly withdrawn and the same procedure using oily contrast medium (Lipiodol Ultra Fluid, Guerbet, France) was repeated. With the water soluble contrast medium the thoracic duct was filled in 15-20 minutes, with the oily agent in 20-30 minutes.

#### RESULTS

In 1 of the patients (Fig. 1) one orifice of the thoracic duct was not ligated, resulting in a phlebogram of the jugular vein at injection of contrast medium. In the remaining patients the thoracic duct was filled to the level of the tenth or eleventh thoracic vertebral bodies with both water soluble and oily contrast medium (Fig. 2,  $\mathcal{A}$  and  $\mathcal{B}$ ). In 2 patients some smaller tributary lymph

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vessels were visualized (Fig. 3), while in I of the patients several lymph vessels were opacified (Fig. 4, A and B) using oily contrast medium and high injection pressure. In no case was a lymph node visualized. No pathologic processes could be identified with certainty.

#### COMPLICATIONS

Extravasation occurred at the cannulation site in 2 cases. In 1 of them some Lipiodol could be identified 4 months later (Fig. 5), while the other case was normal. In 1 of the patients (Fig. 4A) the extravasation extended far down into the mediastinum without causing the patient any discomfort or clinical symptoms.

#### DISCUSSION

Until the present time, pedal injection of



Fig. 1. Water soluble contrast medium passing partly down the thoracic duct, but mainly into the sub-clavian vein as one orifice of the duct was not ligated.

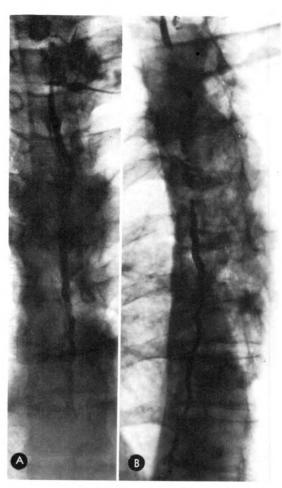


Fig. 2. (A and B) Water soluble and oily contrast medium, respectively. No tributaries filled. Note the haziness of the outlines in A, possibly due to diffused contrast medium.

oily contrast medium has been the only method of opacifying the thoracic duct. With this technique, however, it is impossible to obtain a continuous filling of the duct and no visualization of the tributaries occurs. A retrograde technique has been reported by Battezatti et al.,² but their technique seems not to have been successfully applied by other research workers. Kinmonth⁴ reports failure to make retrograde injection of the thoracic duct more than a few cm. due to the valves. A grossly dilated duct may be opacified retrograde as has been reported in I case of subclavian vein thrombosis by Arvay and Picard.¹

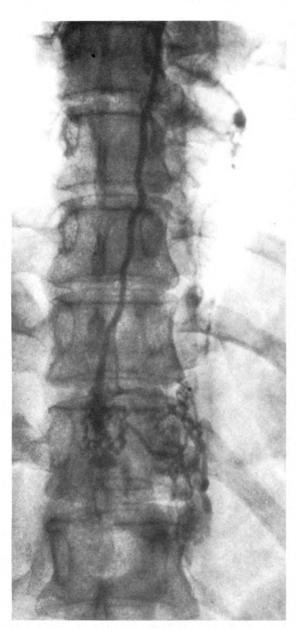


Fig. 3. On the left side of the thoracic duct water soluble contrast medium has passed into tributaries at the height of the 7th and 11th thoracic vertebrae. There may be a block for the passage of contrast medium at the lower vertebrae due to a pathologic process.

The thoracic duct can, to some extent, be compared with a vein. The valves, however, are situated much closer than in veins, the average number of valves in the thoracic duct being about 22.3 The duct wall con-

sists of 3 cell layers, I epithelial lining, and 2 outer muscle layers, I with circular smooth muscles and I with long spiral muscles. This anatomy must be considered when the possibility of making retrograde angiography in a lymph vessel is discussed.

The retrograde filling of the thoracic duct according to our experience is dependent on: (a) variations in the respiratory phase; (b) variations in the position; (c) the Valsalva maneuver; (d) the injection pressure; and (e) the viscosity of the contrast medium.

The patients sometimes inspire and sometimes expire heavily. With a low injection pressure or infusion, it takes a very long time to pass the valves, but with moderate injection pressure the time consumption is considerably decreased. The explanation must be that by this latter approach the walls of the thoracic duct are expanded, making the valves insufficient. It is easier to pass the valves with a water soluble contrast medium, but better filling and better visualization of the tributaries are obtained with oily contrast medium. An attempt to pass the opening of the valves by giving the patient saline to drink in order to increase the lymph stream did not help.

It is important to start the examination with water soluble contrast medium as is demonstrated in Figure 1, to avoid greater amounts of oily contrast medium reaching the systemic circulation. It is also important at operation to try to make sure that all orifices into the subclavian vein are ligated.

We hope that by using retrograde angiography of the thoracic duct it will be possible to demonstrate lesions in the vicinity of the duct, e.g., metastases. We have not been able to do so in our cases which may, however, be due to absence of pathologic processes in the mediastinum. We have had no case of chylothorax, which we believe could be diagnosed with this method.

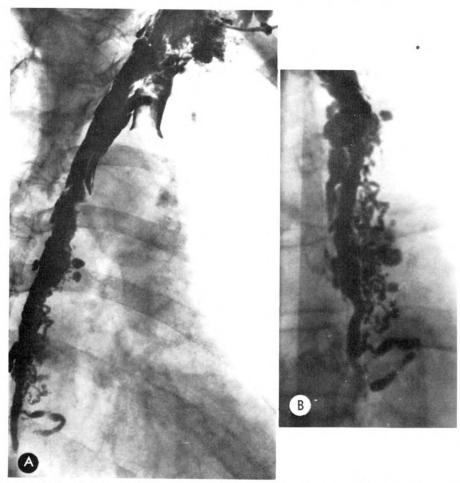


Fig. 4. (A and B) Oily contrast medium extravasating into the mediastinum. Note the extensive visualization of tributary lymph vessels in the lower part of the mediastinum, possibly due to high injection pressure.

The possible complications of lung emboli mean that the same restrictions in the selection of patients as in pedal lymphangiography should be applied. The extravasations did not cause the patients discomfort or any clinical symptoms. The extravasations have occurred mainly when oily contrast medium was used.

#### SUMMARY

After operative cannulation of the thoracic duct, retrograde injection of water soluble and oily contrast medium, respectively, was performed in 6 patients.

Opacification of the duct and some tributaries was obtained.

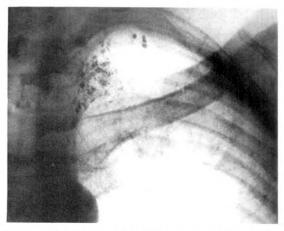


Fig. 5. Extravasated oily contrast medium at the cannulation site 4 months after the examination.

The method may prove to be valuable in demonstration of pathological processes in the mediastinum, e.g., metastases and chylothorax.

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# RAPID COMPUTERIZED LUNG VOLUME DETERMINATION FROM CHEST ROENTGENOGRAMS\*

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A SYSTEM which permits rapid determination of total lung capacity from chest radiography by computerized graphic-to-digital conversion of tracings was developed and tested in our institution.

Barnhard et al.2 devised a method of radiologic lung volume determination based on numerical summation of infinite numbers of elliptical cross sections of the thorax. The parts which represent the heart, the areas below the diaphragm, the lung tissue volume, and the pulmonary lung volume were subtracted from the calculated total thoracic volume. In order to reduce measurement time, the number of elliptical cylindroids was limited to 5. Loyd et al.10 further refined Barnhard's approach by using improved data for the determination of blood volume and dry tissue volume of the lung. Nicklaus et al. 13 verified the usefulness of the ellipse method of Barnhard.

Hurtado et al.<sup>8</sup> first suggested planimetry for radiologic lung volume determination. Cobb et al.<sup>3</sup> used this method with slight modifications and found good correlations between the radiologic and physiologic measurements. Gildenhorn and Hallett<sup>6</sup> found essential agreement between the ellipse method and planimetry. A modification of the planimetry method was developed by Pratt and Klugh<sup>14</sup> using a regression formula. This method was further modified by Harris et al.<sup>7</sup> Jaffe<sup>9</sup> suggested the use of digitizers for quantitative analysis of roentgenograms, particularly lung volume determinations.

It is apparent that total lung capacity can be accurately determined from chest roentgenograms obtained in maximum deep

inspiration, but the complexity of existing methods precluded practical application.

The description of our rapid method and the comparison of the results with body plethysmography and helium dilution techniques are the subjects of this paper.

#### MATERIAL AND METHOD

#### I. MATERIAL

Total lung capacity determinations were made in 53 patients with the radiologic and helium dilution techniques. In addition, 42 of these patients also had body plethysmography. Of the 53 subjects studied, 17 were normal and 36 had pulmonary abnormalities.

#### 2. RADIOGRAPHY

Standard posteroanterior (PA) and left lateral chest roentgenograms were obtained at a 6 foot target-to-film distance. A specially trained x-ray technologist instructed the patients to take a maximum deep inspiration during the exposure. Subsequently the vital capacity was determined by electronic spirometry\* in all patients.

## 3. RADIOLOGIC LUNG VOLUME

Instrumentation. The chest roentgenograms were placed on a 60×90 cm. backlighted transparent plate with two linear microphones along the top and left sides. The outlines were traced with a pen which emitted a hypersonic sound wave generated by the spark gap system built in the stylus. The sound signals were analyzed and ex-

<sup>\*</sup> Spirostat, Marion Laboratories.

<sup>\*</sup> From the Department of Radiology, Harvard Medical School and Peter Bent Brigham Hospital, Boston, Massachusetts. Supported in part by USPHS grant GM18674.

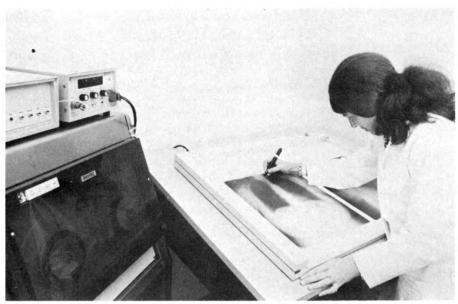


Fig. 7. The tracing tablet.

pressed as the x, y coordinate position of the pen.† After the positional information was converted into digital data, it was recorded on a magnetic tape. Essential data regarding the patient were recorded on a key board along one side of the tablet. The data reduction and computation were carried out by a PDP 11/20 computer with a resolution of 0.001 inch (Fig. 1).

Tracing procedure. The outlines of the lungs, heart and mediastinal border were traced from each set of films. The outer lung margins were clearly visible on the PA projection and could be followed by the operator without difficulty. The apex of the lung was determined by the inferior margin of the posterior aspect of the first rib (Fig. 2A). The outline of the heart was distinct with the exception of the superior aspect where a horizontal line was drawn at the level of the upper margin of the aortic knob. On the lateral projection, the anterior aspect of the lung margin was distinct up to the apex where it became poorly visible and the tracing stopped. The apical part of the contour was reconstructed by the computer program. The posterior lung

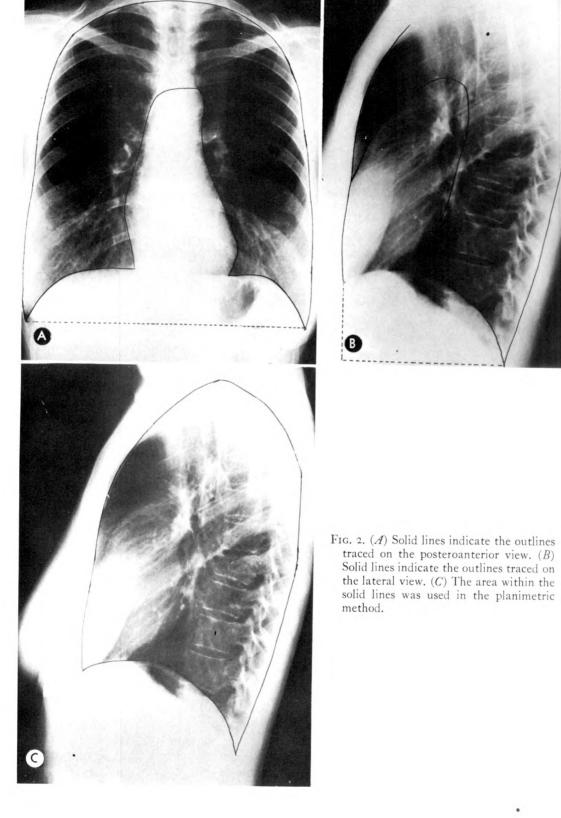
† Graf pen, Sac Corp., Southport, Ct.

margin was clearly visible below the apex. If the two rib cages were not exactly superimposed, the outer margin was followed. The upper diaphragm was always traced (Fig. 2B).

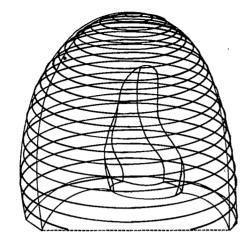
Calculations. The data were analyzed by 2 methods. With the first method the total chest volume and the volumes of the heart, mediastinum and the subdiaphragmatic regions were determined by an integration routine which calculates the desired volumes as the sum of elliptic slices, (Fig. 3). The slice thickness was a variable program parameter. The pulmonary tissue volume was estimated to be 2.7 ml. per pound of body weight and the pulmonary blood volume as 230 ml. per m.<sup>2</sup> of body surface. 10

A planimetric method for lung volume determination was adapted from a report by Harris *et al.*<sup>7</sup> The regression formula was  $8.5 \times (\text{posteroanterior lung surface} + \text{the entire lateral surface}) - 1,200. The posteroanterior lung surface included the entire area within the solid lines of Figure 2A. The lateral surface area included the area outlines in Figure 2C.$ 

The radiologic residual volume (RV) was determined by subtracting the vital ca-



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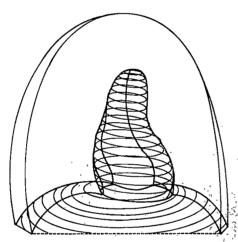


Fig. 3. Diagrammatic illustration of the ellipsoid summation method. (A) The volume of the entired thoracic cavity is determined from the sum of ellipsoids. (B) The volume of the heart and subdiaphragmatic region is determined from the sum of ellipsoids. This sum will be subtracted from the volume of the entire chest cavity.

pacity (VC) from the radiologic total lung capacity (TLC). From the residual volume and total lung capacity, the RV/TLC ratio was also determined.

#### 4. PHYSIOLOGIC MEASUREMENTS

Total lung capacity and its subdivisions were determined by both helium dilution<sup>12</sup> and whole body plethysmography.<sup>4</sup> Helium equilibration was continued until the readings from the helium catherometer were stable for 2 minutes. Recordings were taken every 30 seconds. Thoracic gas volume

(TGV) was measured by the method of Dubois et al.<sup>4</sup> Mouth and plethysmographic pressures were recorded using Statham PM5 and PM97 transducers, respectively. After appropriate amplification, the outputs of these two devices were then displayed as the x, y coordinates of a storage oscilloscope. The plethysmographic functional residual capacity (TGV) was computed as the mean of 5 separate determinations. All volumes were expressed in body temperature, pressure saturated (BTPS).

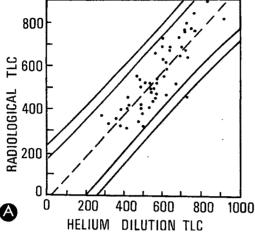
#### RESULTS

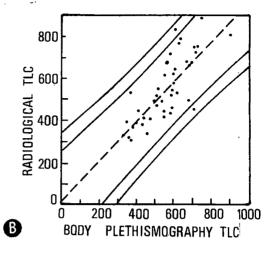
Figure 4 shows the correlation in scatter-grams among the radiologic total lung capacity determination, the helium dilution and body plethysmography methods. The radiologic lung volumes were based on the ellipsoid summation technique. Figure 4B compares on a scattergram the correlation between the two radiologic methods: the ellipsoid summation and planimetric methods. Table 1 is the statistical analysis comparing the two radiologic and 2 physiologic methods. It includes the correlation coefficient, the slope of the best fit, and the standard deviation of the slope.

#### DISCUSSION AND CONCLUSIONS

The digitized tracing method permitted accurate determination of total lung capacity from chest roentgenograms in less than I minute. The correlation between the radiologic methods and the helium dilution method was excellent: r=0.85 for all subjects and r=0.94 for normals (Fig. 4). The correlation for the patients with pulmonary obstructive disease was still good, although less than for normal individuals (Table I).

The correlation between the ellipsoid summation method and the planimetric method was very high, r=0.95 (Fig. 4B; Table 1). There was, however, a slightly better agreement between the physiologic measurements and the ellipsoid method than with planimetry (Table 1). On the other hand, a practical advantage of the planimetric method is that information concerning the patient's age, sex, height,





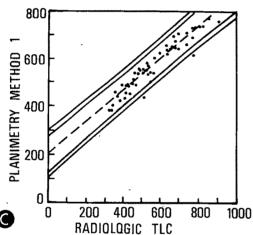


Fig. 4. (A) Correlation between the radiologic ellipsoid summation method and helium dilution method (r=.85). (B) Correlation between the radiologic ellipsoid summation method and body plethysmography (r=.78). (C) Correlation between the radiologic planimetric method and the radiologic ellipsoid summation method (r=.95).

and weight is not required.

The determination of the total lung capacity from chest roentgenograms combined with vital capacity measurements, permitted the calculation of the residual volume (TLC-VC=RV). It is generally accepted that the determination of the residual volume and the RV/TLC ratio is of

TABLE I STATISTICAL ANALYSIS OF THE CORRELATION AMONG THE 2 RADIOLOGIC METHODS (ELLIPSOID SUMMATION AND PLANIMETRY), AND THE 2 PHYSIOLOGIC METHODS (HELIUM DILUTION AND BODY PLETHYSMOGRAPHY)

	r (Correlation Coefficient)					Slope					
		BP Radı	Rad2	lad2 Rad1	Rad2	Radı	BP	Radı	Rad2	Radı	Rad2
		He	He	He	BP	BP	Radz	He	He	He	BP
All Subjects Normals Obstructives	.90 .93 .89	.85 ·94 ·78	.83 .92 ·74	.78 .92 .73	.76 .88 .68	.95 .94 .98	.84±.06 .85±.09 .83±.09	.98±.08 1.33±.12 .93±.14	.68±.06 .80±.09 .62±.11	.95±.12 1.43±.18 .90±.19	.66±.09 .90±.14

Key
BP= Body Plethysmography.
He= Helium Dilution.
Rad1= Radiological Ellipsoid Summation Method.
Rad2= Radiological Planimetric Method.

great importance in the detection and management of patients with chronic obstructive pulmonary disease, since this ratio will often increase before total lung capacity will move out of its normal range.

Chronic obstructive pulmonary disease (COPD) is a major world-wide health problem. In the USA the mortality due to COPD was estimated to be 20,000 in 1964. It is the primary cause of 2.6 per cent of all deaths; it has significantly contributed to death in 4.1 per cent of the remainder. It is related to smoking, air pollution, sclimate, social factors, heredity and urban environments. The diagnosis of COPD is important because the elimination of one or more of the etiologic factors (e.g., smoking) and the meticulous attention to intercurrent pulmonary infections significantly improve the prognosis.

In this country, chronic bronchitis and emphysema are the most widespread forms of COPD. Spasmodic and infectious asthma are somewhat less prevalent. Radiologically, pulmonary emphysema may be recognized by hyperinflation. However, this is a difficult perceptual task early in the course of the disease and it becomes easier only when the process is far advanced. It is uncertain whether any pattern on chest roentgenograms is specific for bronchitis alone.

The chest roentgenogram is one of the most commonly used diagnostic tests. By digital and contour analysis, significant quantitative physiologic information can be obtained which increases the usefulness of the study in the assessment of chronic obstructive pulmonary disease.

#### SUMMARY

A digital tracing method was developed for rapid determination of total lung capacity from chest roentgenograms. The procedure, which requires approximately I minute, was tested in 53 subjects. The calculations were based both on summation of ellipsoids and planimetry. The radiologic methods showed excellent correlation with

each other (r=.95) and also with physiologic measurements (r=.85).

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Seventy-sixth Annual Meeting: Marriott Hotel, Atlanta, Ga., Sept. 30-Oct. 3, 1975.

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Fifty-seventh Annual Meeting: Americana Hotel, San Juan, Puerto Rico, May 4-9, 1975.

## ≈ EDITORIAL ∞

## THE CATEGORICAL REFRESHER COURSE— AN INNOVATION IN REFRESHER COURSE PLANNING

URING the last 8 years considerable thought has been given to the possibility of establishing in-depth courses dealing with the radiology of at least one of the major anatomic systems during each annual American Roentgen Ray Society meeting. It has been postulated that although most radiologists prefer the already available variety of excellent short refresher courses, there are some who desire to use all of the available refresher course time to obtain in-depth coverage of the radiology of one body system each year. We have been primarily concerned about the mechanics of attempting to integrate such an innovation into the already smoothly functioning American Roentgen Ray Society instructional course format. At the annual American Roentgen Ray Society meeting in 1974, the Executive Council decided to try this idea and gave permission to plan such a course for the 1975 annual meeting.

Similar categorical courses will also be held at each of the annual meetings of the Radiological Society of North America and American College of Radiology. Such a course devoted to the radiology of gastrointestinal tract diseases was held at the Radiological Society of North America annual meeting in December, 1974, and the response indicated that this type of course was desired by many radiologists. Thus, such courses have already been organized for the 3 radiological organizations during the next 2 years, and such planning will enable us to publicize several years in advance the category to be offered at each annual meeting of the American Roentgen Ray Society, Radiological Society of North America and the American College of Radiology. It is anticipated that there will be a somewhat cyclic recurrence of the major categories covered, and although such courses will relate primarily to anatomic body systems (chest, gastrointestinal tract, genitourinary tract, skeletal system, nervous system), it is likely that future courses will be given in ultrasound, computerized axial tomography, nuclear medicine, etc. Nevertheless, there will be a cyclic rotation of the major diagnostic categories which can probably be completed every 3 years, assuming that 3 major categorical courses can be given each year.

The systematic planning of instructional courses and their publication in advance will probably be of increasing importance as time goes on, because of the seeming inevitability of some type of re-certification. At the 1975 annual meeting of the American College of Radiology in Portland, Oregon, the counselors approved the concept of continuing medical education as the most acceptable route toward certification. One year earlier this group had already approved a resolution requiring 150 hours of continuing medical education credit every 3 years as a requisite for continuing membership in the American College of Radiology. Sixty hours of the total must be in the form of the AMA Category 1 type of credit.

In view of the future re-certification problem, the counselors at the Portland meeting approved the concept of requiring that 30 of the 60 hours of Category I type credit obtained every 3 years be "validated" by an examination at the end of the courses. Previous experience in giving such

examinations at the end of the American College of Radiology Weekend Symposia, and the information gained from the "Pre" and "Post" testing experiment at the categorical course on gastrointestinal tract radiology at the 1974 annual meeting of the Radiological Society of North America, had shown that the vast majority of radiologists would pass such examinations. However, regardless of the final grade, the mere taking of such an examination at the end of the course would, for the time being, probably suffice for the "validation" of Category I credit. In the event of failure, probably the worst that could happen would be that the radiologist who attended the course would obtain the Category I type credit, but it would not be the "validated" type. However, the credit so obtained would still help to fulfill the required minimum of 60 hours of Category I type credit every 3 years. If more than 60 hours of Category I credit is obtained it would help fulfill the required total of 150 hours every 3 years.

There is a growing consensus among leaders in the specialty of radiology that the re-certification process must have credibility, and as the American College of Radiology counselors struggled to develop an acceptable plan, the "validation" of 30 hours of Category I type credit every 3 years seemed to be a reasonable approach. Thus, the planners of future courses, and the instructors responsible for presenting the courses must emphasize important concepts and practical information during their presentations. Well-planned examinations offered at the end of such courses will almost certainly be passed by the overwhelming majority of registrants who take

It is hoped that the addition of one cate-

gorical course to the refresher course program of each future annual meeting of the American Roentgen Ray Society will provide the opportunity for each radiologist who attends this meeting to choose his own approach to his continuing medical education. Dr. Jerome Wiot has done the lion's share of the work in planning the fine course to be presented at the 1975 annual meeting. He is an original member of the American College of Radiology Committee on Systematized Refresher Course Planning which was established several years ago in the Division of Inter-Society Collaboration on Education of the American College of Radiology Commission on Diagnosis. My other colleagues on this committee who have worked for many years to bring the categorical course idea to fruition are Drs. Atis Freimanis, John Kirkpatrick, Robert Frieberger and David Witten. More recently, in an attempt to add greater versatility to the committee, the following radiologists have joined the committee: Drs. Jack Edeiken, Reed Rice, Bob Heitzman, Tom Beneventano, Charles Gooding, Paul Hoffer, Stephen Keiffer and Richard Pfister. With the dedication and expertise which exists among this talented group of people, and with the future help of many radiological colleagues who are interested in postgraduate medical education, be they in university departments or in private practice, we should be able to plan an outstanding group of categorical courses. We wish to emphasize again that the categorical course innovation is but one small part of the already excellent refresher course program, and the individual short courses will continue to be the most important and numerous components of the instructional course program.

SIDNEY W. NELSON, M.D.



#### AMERICAN ROENTGEN RAY SOCIETY

#### SECTION ON INSTRUCTION

HAROLD O. PETERSON, M.D., Director

EUGENE GEDGAUDAS, M.D., Associate Director

Titles and Abstracts of Courses Offered Seventy-Sixth Annual Meeting Marriott Hotel, Atlanta, Georgia September 29-October 3, 1975

THE INSTRUCTION COURSES for the Seventy-sixth Annual Meeting of the American Roentgen Ray Society will be held on Monday, Tuesday, Wednesday and Thursday afternoons, September 29, 30, October 1 and 2 at 3:00 P.M. and Friday morning, October 3, at 11:00 A.M.

Each course will last about 90 minutes during which time there will be no other activity scheduled. The courses were scheduled on Friday morning at 11:00 A.M. for the first time last year and this proved to be so successful, it will be continued this year.

In addition to the regular courses of which there will be 64 periods, there will be, for the first time, a series of courses dealing entirely with the Chest. This is described in detail below. Please observe that the "Categorical Courses" on the Chest will cover a period of 6 days and a total of 16 hours, and it will not be possible to take any other courses if one signs up for the Chest Program.

A separate registration desk for the Instructional Courses will be located in the general registration area and will be open beginning at 9:00 A.M. Sunday morning, September 28. Complete information concerning the courses and sale of any remaining tickets will be available there.

The "Categorical Course on the Chest" will begin on Sunday and will be the only subject presented on Sunday. There will be 9 courses on Monday and 15 on Tuesday, Wednesday and Thursday; 10 courses on Friday morning. A complete list of the faculty and abstracts for each course are included on the following pages. At the end of this section there is a pink registration

form which should be completed in detail and mailed in promptly if you wish to get tickets for the courses of your choice.

Tickets will be mailed to everyone whose registration (pink sheet) reaches the office of the Director before Friday, September 19, 1975. Please watch for your tickets which will be mailed in an envelope marked "Section on Instruction, American Roentgen Ray Society—Tickets Enclosed." The first mailing will be early in September. Any requests for tickets which arrive after the deadline will not be mailed but will be honored at the Instruction Course registration desk in the hotel.

## HOW TO REGISTER AND OBTAIN TICKETS

Review the abstracts on the following pages; make 3 choices for each day; fill out the pink order form with the course number and name of instructor for each choice. For each course selected a \$3.00 registration fee is required from nonmembers. If you select 5 courses, one each day, the cost will be \$15.00.

Members of the American Roentgen Ray Society, graduate students or residents in radiology or nonmembers who are contributing to the program by way of an instruction course, a paper on the scientific program or a *scientific* exhibit, are not required to pay for these courses but must fill out a pink order form indicating their choices, and check the proper box opposite name and address.

Everyone who registers for the Categorical Course in Chest Diseases must take the entire series and pay the \$25.00 fee. This

includes members of the American Roentgen Ray Society. The Categorical Course includes a total of 16 hours of instruction and a syllabus.

Please mail your order as promptly as possible to Dr. Harold O. Peterson, 1995 West County Road B, St. Paul, Mn. 55113.

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### CATEGORICAL COURSE ON CHEST DISEASES

JEROME F. WIOT—Course Coordinator SIDNEY W. NELSON—General Chairman

> Sunday, September 28 through Friday, October 3, 1975

### PLEASE NOTE:

This course extends over a period of 16 hours using up all the available time for Instructional Courses. If you select this course, do not register for any of the others.

Fee—\$25.00 (includes syllabus)

Must be paid by everyone which includes members, nonmembers, residents, etc.

### COURSE OUTLINE

### Sunday

I:00-2:00 P.M.

The Roentgen Work-up of Pulmonary Disease with Special Emphasis on Newer Diagnostic Techniques. John Fennessy, M.D.

2:00-3:00 P.M.

The Chest Wall, Pleura and Ex-

	tra Pleural Space. Vernon Vix, M.D.
3:00-4:00 P.M.	The Mediastinum—Normal and Abnormal. Heinz Weens, M.D.
4:00-5:00 P.M.	Abnormalities Peculiar to the Pediatric Age Group, Part I. Edward B. Singleton, M.D.
Monday	
I:00-2:00 P.M.	Abnormalities Peculiar to the Pediatric Age Group, Part II. Edward B. Singleton, M.D.
2:00-2:45 P.M.	Radiologic Pathologic Correlation, Part I. E. Robert Heitzman, M.D.
2:45-3:30 Р.М.	Radiologic Pathologic Correlation, Part II. E. Robert Heitzman, M.D.

Pattern Recognition in Pulmo-

nary Disease, Part I. Benjamin

Pattern Recognition in Pulmonary Disease, Part II. Benjamin

## Tuesday

3:30-4:15 P.M.

4:15-5:00 P.M.

3:00-4:00 Р.М.	Obstructive Airway Disease. Robert G. Fraser, M.D.
4:00-5:00 P.M.	Malignancies of the Lung. Led G. Rigler, M.D.

Felson, M.D.

Felson, M.D.

## Wednesday

3:00-4:00 P.M.	The Pneum oconioses, E. Nicholas
	Sargent, M.D.
4:00-5:00 P.M.	Granulomatous Disease, etc.,
	Other Infections. Elias G. Theros,
	M D

### Thursday

3:00-4:00 P.M.	The Traumatized Lung. Reginald Greene, M.D.
4:00-5:00 P.M.	Immunologic Diseases and Opportunistic Infection. Stewart R. Roberts, M.D.

### Friday

II:00-I2:00 A.M.	Pulmonary Vasculature. Richard
	H. Greenspan, M.D.
12:00-1:00 P.M.	Pulmonary Embolus. Alexander
	Gottschalk, M.D.

This 16 hour course will emphasize reliable and fundamental diagnostic radiological concepts and radiologic-pathologic correlations of importance in the evaluation of a wide variety of pulmonary diseases. An outstanding group of instructors will cover the subject in a systematic sequence. It is anticipated that this course will appeal to radiologists who wish to plan their continuing medical education by covering one body system each time they attend the an-

nual meeting. It should be emphasized that registration will be on an "all or none" basis; i.e., registrants must sign up for the entire course, rather than for individual parts of it. Registrants for the entire course will not be able to obtain tickets for other courses which are given at the same time as the categorical course. An illustrated syllabus will be available for each registrant for the entire course; the cost for this syllabus is included in the registration fee of \$25.00 for this course. Syllabi will not be available to those who do not register for the entire course.

This course will provide approximately 16 hours of AMA Category I credit, and an examination will be offered at the end of the course for those wishing to obtain "validation" of these credits.

# DESCRIPTION OF COURSES COURSE 101

### Monday

## GLEN W. HARTMAN, M.D. Rochester, Minnesota

## Excretory Urography—Individualization of the Examination

Numerous advances have been made in the performance of excretory urography in recent decades. Most radiologists can readily recall when it was standard practice to use a relatively small dose of contrast medium and to obtain a few standard views without monitoring the examination. As a result, the renal outlines were seldom demonstrated and the collecting systems rarely filled. Masses and scars went undetected and retrograde pyelography was an essential supplementary examination. We have advanced beyond this level of practice, but it is apparent that the consistent production of high quality excretory urography requires the continuing careful attention of the radiologist. Even before the examination, the radiologist must select the contrast media, the film-screen combination, and the type of x-ray equipment which will give the best results. He must also be certain that his film processing system is functioning at an optimal level.

It is desirable to standardize certain basic steps of the excretory urogram, but the examination of each patient must be individualized beginning with the preparation. The advantages and disadvantages of laxatives, enemas, and fluid restriction will be briefly discussed. Dosage of contrast medium should vary according to the patient's weight, status of renal function and whether or not ureteral compression is to be employed. The timing and type of films to be obtained depend on the indication for the examination

It is essential to demonstrate clearly all of the renal parenchyma bilaterally. This can be done by monitoring excretory urograms and varying the procedure as necessary. Routine tomography is the most dependable method of depicting parenchymal lesions.

The relative value of various views such as prone, oblique, upright, and post-void will be emphasized as will the use of fluoroscopy in the evaluation of ureteral pathology.

### COURSE 102

### Monday

# REED P. RICE, M.D. Durham, North Carolina

## Radiologic Evaluation of the Acute Abdomen

This course is designed to illustrate the value of radiology in the evaluation of the patient with acute abdominal symptomatology.

This will include the value of the plain abdominal roentgenogram in the specific diagnosis of diseases, but will also provide a guide to the contrast examination of choice in appropriate situations.

An aggressive approach to the use of simple contrast examinations can result in significantly earlier diagnosis.

### COURSE 103

## Monday

# JACK EDEIKEN, M.D. Philadelphia, Pennsylvania

## A Rational Approach to Bone Radiology

The discussion will include a rational approach to the diagnosis of bone lesions in general and bone tumors specifically. The aggressive and non-aggressive, periosteal reaction, age consideration, and matrix calcification will also be discussed.

Important pathology considerations will be brough t out, indicating the role of the radiologist in advising the pathologist.

COURSE 104 and COURSE 204

Monday and Tuesday

## ARNOLD CHAIT, M.D. Philadelphia, Pennsylvania

### Abdominal Angiography: Part I

Following more than a decade of explosive expansion, abdominal angiography has now taken its place among the more expensive, but no longer very "special" radiologic procedures. Its applications are well understood and its limitations recognized.

The first session of this 2 day course will concentrate on a demonstration of the angiographic patterns of disease of the abdominal aorta and viscera profused by its branches including the liver, pancreas,

spleen and gut, as well as omentum and mesentery in adults and children.

There will be a discussion of neoplastic, inflammatory, traumatic, and primary vascular diseases.

### Part II

The second session will consist of a discussion of techniques of manipulation of blood flow to the abdominal viscera and will include such topics as the angiographic diagnosis and pharmacologic control of gastrointestinal bleeding, transcatheter management of non-occlusive mesenteric ischemia and the use of autogenous clot in the control of pelvic and renal hemorrhage. Emphasis will be on the practical rather than the esoteric. These techniques are readily mastered and should be available in any institution equipped for the performance of angiographic procedures.

Time permitting, there will be a discussion of hazards of angiography with suggestions for minimizing them.

### COURSE 105

### Monday

# JOHN N. WOLFE, M.D. Detroit, Michigan

### Xeroradiography

The presentation will have several divisions. They are as follows:

- I. General remarks: a brief description of the xeroradiographic process followed by examples of its use in mammography. Also presented will be material citing its advantages and disadvantages. Areas under investigation such as negative mode mammography will be discussed. A review of technique difficulties will be shown.
- 2. General application of xeroradiography: a presentation of where xeroradiography appears to have advantage over conventional film mammography and at the same time where it has disadvantages. There will be illustrative examples of the various applications and some remarks on technique such as judging overexposure and underexposure.

### COURSE 106

### Monday

EUGENE L. SAENGER, M.D. Cincinnati, Ohio

Bone Scanning: Tumor Localization
(45 minutes of this period)

ROBERT H. WILKINSON, JR., M.D. Durham, North Carolina

(45 minutes of this period)

### COURSE 107

### Monday

# BARRY B. GOLDBERG, M.D. Philadelphia, Pennsylvania

### An Introduction to Diagnostic Ultrasound

Diagnostic ultrasound has assumed ever increasing importance in medicine, particularly as an adjunct to many radiological procedures.

This course will provide information on the diagnostic uses of ultrasound utilizing all 4 established modes of display, i.e., A-mode, M-mode, Doppler and B-scan including gray scale. The basics of physics and instrumentation will be provided. Emphasis will be placed on the established uses of ultrasound in all areas of the body including the head, chest, abdomen, and pelvis.

A course outline as well as a list of available books will be distributed.

### COURSE 108

### Monday

## KENNETH R. KATTAN, M.D. Cincinnati, Ohio

### Tricks and Treats in Tomography

A tomogram is not exactly synonymous to a roentgenogram of an anatomic cut.

The course describes the different pitfalls in tomography and how to avoid them. The Law of Tangent is stressed and its clinical applications are described. Mention is also given to the application of Law of Tangent to a curved surface.

Parasitic and phantom shadow formations are explained in diagrams and clinical examples of each are given. The importance of proper rotation of the patient and the proper direction of the tube in order to decrease distortion of the image is mentioned. This is feasible only if proper examination of the study is initiated. The conventional roentgenogram (and sometimes fluoroscopy) is done before initiation of the tomographic study.

The various tube movements, the different thickness of the cut and the degree of spacing between the cuts in different studies are reviewed.

### COURSE 100

### Monday

M. M. SCHECHTER, M.D. Bronx, New York

J. A. MARC, M.D. Atlanta, Georgia

## A Simplified Approach to Posterior Fossa (Vertebral) Angiography

A practical guide to interpretation of angiography

of the posterior fossa will be presented.

The normal arterial and venous angiographic anatomy will be shown and correlated with specimens and simplified with line drawings and geometric designs.

The angiographic findings in pathologic conditions involving the brain stem, cerebellum, fourth ventricle, cerebellopontine angle, foramen magnum and tentorium will be correlated with gross pathology.

An outline summary of the course will be distributed.

### COURSE 201

### Tuesday

### RICHARD M. FRIEDENBERG, M.D. New York, New York

## Non-Neoplastic Lesions of the Kidney and Ureter

This course will review the common lesions of the kidney which are non-neoplastic and, in most cases, do not produce tumefactive masses.

The course will start with a brief discussion of the basic diagnostic principles of pyelonephritis and some of the more common variations seen in pyelonephritis such as xanthogranulomatous pyelonephritis. Following this, a spectrum of diseases with their pathophysiology and differential characteristics will be discussed. These lesions will include papillary necrosis, tuberculosis, medical lesions producing arteritis in the kidneys, fungus diseases, and some comments on the pathophysiology of ureteral dysperistalsis, pyelo sinus reflux, and megaloureter.

### COURSE 202

### Tuesday

### RICHARD H. MARSHAK, M.D. New York, New York

### Lesions of the Colon: a Pathologic and Roentgen Correlation

- 1. Lymphosarcoma
- 2. Familial polyposis
- 3. Endometriosis
- 4. Mucocele
- 5. Unusual vascular lesions of the colon
- 6. Pneumatosis
- 7. Colitis Cystica Profunda
- 8. There will be a discussion of polyps of the colon and their relationship to malignancy and much abused colonoscopy. Other lesions will also be discussed, such as diverticulitis, if time permits.

### COURSE 203

### Tuesday

# WILLIAM MARTEL, M.D. Ann Arbor, Michigan

### Differential Diagnosis of Arthritis

This course will consist of a series of vignettes highlighting certain features which have special diagnostic significance, particularly in the context of conditions commonly confused with one another or missed entirely.

The discussion will deal with rheumatoid arthritis, osteoarthritis, gout, pseudogout, lupus, ankylosing spondylitis, ischemic necrosis and other conditions.

### COURSE 205 and COURSE 305

Tuesday and Wednesday

JOHN N. WOLFE, M.D. Detroit, Michigan

### Mammography: Part I and II

The course is designed to present principally problems in mammographic diagnosis. A portion of the time will also be devoted to a group of short subjects which are deemed important but not discussed too frequently.

After a brief introduction presenting some highlights of mammography and touching very briefly on technique and equipment, the following subjects will be presented: (1) carcinoma of the breast; (2) differential diagnosis of uncalcified breast masses; (3) differential diagnosis of breast calcifications; (4) the axilla; (5) the skin; (6) prominent duct pattern; and (7) indicators of risk for the development of breast cancer.

No attempt will be made to cover all aspects of breast diagnosis. Most of the illustrative material will be by xeroradiography. It is not believed that this will hamper those who are more accustomed to film mammography because the morphology of a tumor or calcifications on a xeroradiogram of the breast is the same as observed on film.

### COURSE 206

Tuesday

DAVID H. BAKER, M.D. New York, New York

WALTER E. BERDON, M.D. New York, New York

Varied and Unusual Sequelae in Both Systemic and Primary Bone Disease in Children

The growing skeleton has a very significant carti-

lage component which limits our ability to assess both short and long term effects of injury or disease. We would like to stress this aspect of acquired bone disease in children, with examples of both usual and unusual skeletal insults and their effects from trauma, infection, arthritis, neoplasm, and radiation. The emphasis will be practical.

### COURSE 207

### Tuesday

# C. BENJAMIN GRAHAM, M.D. Seattle, Washington

# Persistent Myths which Confuse and Complicate Children's Radiology

Many misconceptions exposed here are longstanding and well entrenched in medical lore. The corresponding truths are almost equally old, but unfortunately they remain generally poorly known or understood. Healthy and sick children alike will profit if their radiologists recognize that:

- Skeletal maturation assessment and growth potential prediction are rather imprecise and greatly overutilized.
- The normal bone age range is surprisingly wide, even encompassing most short boys and tall girls.
- Periosteal new bone, metaphyseal bands and beaks, and irregular or fragmented ossification centers are predominantly normal developmental phenomena.
- The only radiographic sign in the newborn of so-called congenitally dislocated hip is actual subluxation.
- Lumbosacral spina bifida occulta is very common and represents no more than an anatomic variation.
- Vertebral beaking is a greatly misunderstood deformity associated with certain disorders, coming in a confusing but meaningful array of sizes and shapes.
- Wormian bones and J-shaped sella turcica are to be expected in the infant skull and persist longer in immature individuals.
- 8. Normal newborn kidneys are strikingly large and usually function relatively poorly.
- 9. The infant urinary tract requires, and its systems allow, significantly higher urographic doses for optimum demonstration.
- 10. Developmental abnormalities of bladder outlet and posterior urethra, excluding valves in males, are virtually nonexistent.
- 11. Diaphragm level alone is a most inexact method for evaluating degree of inspiration or aortic catheter position.
- 12. The normal thymus may be huge, interfering with cardiac evaluation and masquerading as mediastinal disease in later childhood.

13. Neonatal atelectasis, aspiration, and pneumonia remain much overdiagnosed, while widespread misunderstandings regarding the more prevalent newborn respiratory problems continue.

It is hoped that, as "truths" prevail over "myths," there will be time for spirited discussion.

#### COURSE 208

### Tuesday

# A. S. MACMILLAN, JR., M.D. Boston, Massachusetts

### Sinuses and Orbits-The Facial Region

The use of 8 standard views with modified accessory views provides accurate scout film evaluation of the entire facial area. Catheter and other techniques are done under fluoroscopic spot film control.

Pleuridirectional tomography is principally used in anteroposterior and lateral projections with fewer basal and reverse optic canal views.

Numerous disease, trauma-fracture, infection and inflammation, paranasal sinus and nasopharyngeal masses are seen, in about this order.

The orbit, including the sella is frequently involved by regional disease. Specific orbital lesions are: (1)? IOFB; (2) unilateral exophthalmos using standard clinical and laboratory methods has been studied by many methods. B scan ultrasound and CAT scanning are newer non-invasive accurate methods.

### COURSE 209

(45 minutes each)

Tuesday

# ROBERT W. MC CONNELL, M.D. Dallas, Texas

# Radionuclide Imaging Studies for Evaluation of Liver, Spleen and Pancreas

Hepatic perfusion, function and morphology, as well as visualization of the spleen and pancreas will be discussed in detail.

Morphologic studies of the liver will be placed in their proper perspective. The limitations of these studies, as well as pancreatic scanning, together with correlation with other diagnostic studies will form the major portion of this refresher course.

# EDWARD V. STAAB, M.D. Chapel Hill, North Carolina

## Renal Nuclear Medicine

Recent advances have changed Renal Nuclear Medicine studies from screening to definitive examinations in many instances. Newer radiopharmaceuticals that increase the resolution in imaging studies make these techniques in selective instances the ones of choice for evaluating patients with potential space occupying lesions.

New ways to use many of the radiopharmaceuticals for evaluating patients with genitourinary abnormalities have been developed and evaluated clinically.

The combination of the sensitive functional measurements that are obtained with radiopharmaceuticals and simultaneous imaging with camera systems has improved the specificity of older techniques.

This course will primarily concern itself with the clinical usefulness of Renal Nuclear Medicine in: (1) renal failure; (2) space occupying lesions; (3) urinary tract obstructions; (4) trauma; (5) children (neonates); (6) hypertension; (7) reflux; (8) residual bladder contents; (9) transplantation; and (10) kidney preservation.

### COURSE 210

Tuesday

# GEORGE R. LEOPOLD, M.D. San Diego, California

### Abdominal Ultrasonography

This course will emphasize the wide applicability of ultrasonic radiography in the diagnosis of abdominal disorders. Following a discussion of the normal anatomy of the various organ systems, pertinent examples of pathological disturbances will be presented.

Abdominal imaging has been greatly facilitated by the introduction of the gray scale technique which permits display of intra-organ parenchymal echoes and a large number of vascular structures that previously could not be discerned. The resultant image enhancement is certain to assure greater popularity of the technique among radiologists interested in gastrointestinal disease.

## COURSE 211

Tuesday

# WILLIAM R. HENDEE, Ph.D. Denver, Colorado

## Innovations in Diagnostic Radiology

Recent developments in diagnostic radiologic equipment have expanded and improved the applications of radiologic imaging procedures to clinical medicine. In many cases, these developments have been achieved at the price of simplicity of the equipment, and increased information about equipment specifications and operation is now required of persons responsible for selecting and using radiologic equipment in a clinical setting. Unfortunately, this information is not always easily accessible. Improve-

ment of the accessibility of this information is the purpose of this course.

Topics to be considered in this equipment-oriented course include: rare earth screens and matched film requirements, millisecond exposure timing including photo-timing, the problems of focal spot specifications, and the matching of x-ray tube, generator, and image receptor characteristics.

Additional topics will be considered as time permits, and an outline of the presentation will be distributed as part of the course.

### COURSE 212

Tuesday

## MELVIN P. JUDKINS, M.D. Loma Linda, California

### Imaging Techniques and Equipment Requirements for Cinefluorography

This course is designed to assist the radiologist in improving cineflurographic imaging techniques in his hospital. The advent of the cesium iodide intensifier has materially improved imaging quality. However, the characteristics of these new imaging systems require significant changes in all aspects of this imaging technique.

The topics to be covered will include: (1) the radiographic requirements; (2) design characteristics of the cesium iodide intensifier; (3) the selection of an image intensifier for specific techniques; (4) optics; (5) the cine camera; (6) the selection of a film for cineflurography; (7) cine processing requirements; (8) the cine processor; and (9) viewing.

### COURSE 213

Tuesday

LAWRENCE H. A. GOLD, M.D. Minneapolis, Minnesota

# A Simplified Approach to Posterior Fossa Angiography

A 90 minute course will be given, reviewing the anatomy and pathology found in the posterior fossa. An easy and uncomplicated approach will be stressed, keying on only a very few important vessels. The emphasis will be on gross anatomy and radiologic correlation.

### COURSE 214

Tuesday

DEREK C. HARWOOD-NASH, M.B., CH.B., F.R.C.P. (C) Toronto, Ontario, Canada

The Pediatric Spine and Myelography

A basic knowledge of the development of the spine

is essential in order to better understand the various significant anomalies of the spine and variations that may be considered normal.

Myelography in infants demands a special and precise technique and together with the associated anomalies of the spine will detect congenital and neoplastic lesions that are peculiar to the infant age group.

This presentation will discuss the philosophy and practical aspects of the diagnosis of such lesions in this age group.

### COURSE 215

Tuesday

NORMAN E. CHASE, M.D. New York, New York IRWIN I. KRICHEFF, M.D. New York, New York

## Computerized Axial Tomography

A presentation of the technique and principles of the C.A.T. Scanner will be given and a number of areas where the C.A.T. Scanner is particularly useful in the diagnosis of diseases of the brain will be presented.

In addition, a number of typical cases of various types of cerebral disease, neoplasm, atrophy, vascular disease, etc., will be demonstrated.

### COURSE 301

Wednesday

### JOHN R. THORNBURY, M.D. Ann Arbor, Michigan

### Renal Cystic Disease in Adults and Children

A brief review of current thoughts about the embryologic basis for the pathogenesis of cystic renal disease will be presented.

The first portion of the course will be devoted to a presentation of the spectrum of the infantile polycystic disease/renal dysplasia/adult polycystic disease diagnostic problem. Subsequently, medullary cystic disease, benign simple cyst (single and multiple), and medullary sponge kidney will be discussed and put into perspective. Current concepts of the hereditary aspects of the various entities will be included.

The aim of the course will be to present all you want to know about this ambiguous area of renal disease so that you can solve the diagnostic problems in reasonable fashion in daily practice.

### COURSE 302

### Wednesday

## RICHARD H. MARSHAK, M.D. New York, New York

### The Small Intestine

- 1. Technique
- Immuno-deficiency diseases. These include dysgammaglobulinemia, giardiasis, intestinal lymphangectasia, amyloidosis, etc.
- 3. Lymphosarcoma and Hodgkin's disease
- 4. Miscellaneous small bowel diseases related to malabsorption. If time permits, some ischemic lesions of the small bowel will be discussed.

### COURSE 303

### Wednesday

# M. B. OZONOFF, M.D. Newington, Connecticut

### Disorders of the Hip in Children

Hip abnormality in children may represent a local manifestation of systemic disease, or an entity limited to the hip. In either category, subsequent evolution of the disorder is strongly influenced by normal growth and maturation processes.

The presentation is divided into 4 topics. The first will describe the developmental anatomy of the cartilaginous and ossific epiphysis, growth plate, vascular supply and surrounding soft tissue structures. Normal variants and arthrographic anatomy will be discussed.

The second section will cover the plain film and arthrographic diagnosis of neonatal hip dislocation, with emphasis on early recognition, radiologic techniques, and late sequelae.

The next portion will center around the diagnosis of avascular necrosis in general, and that of Legg-Perthes disease in particular. A discussion of the latter will involve the differential diagnosis of femoral epiphyseal necrosis, including Gaucher's disease, sickle-cell and other anemias, steroid arthropathy, epiphyseal dysplasia, transient synovitis, normal variants, and other conditions.

Finally, those aspects of local trauma and infection that are altered by the anatomy and development of the hip will be illustrated.

### COURSE 304

### Wednesday

# RICHARD L. WESENBERG, M.D. Denver, Colorado

## The Avant-Garde Approach to the Newborn Chest

The latest concepts in newborn chest film inter-

pretation will be presented. Components of the normal neonatal chest will be analyzed, utilizing practical radiologic criteria. These criteria will then be applied to a discussion of the major types of respiratory distress in the newborn:

- 1. Wet lung disease (T.R.D.N., T.T.N., R.D.S.-Type II)
- 2. Drowned newborn syndrome (D.N.S.)-aspiration of clear amniotic fluid *in utero*
- 3. Hyaline membrane disease (H.M.D., R.D.S.)

Practical points concerning new developments and changing radiographic patterns of the following entities will be presented:

- 4. Perinatal asphyxia syndrome (P.A.S.)
- 5. Meconium aspiration syndrome
- 6. Pulmonary hemorrhage
- 7. Infant of a diabetic mother (I.D.M.)
- 8. Persistent fetal circulation syndrome (P.F.C.)

The course is designed as a primer for those radiologists who are in the uncomfortable position of having to occasionally interpret newborn chest films, despite never having had any training in this highly specialized field. For those radiologists beyond the abecedarian stage, it is also intended to be a refresher course, as well as an introduction to the latest concepts pertaining to the common forms of newborn chest disease. Rare and exotic entities will *not* be discussed as this is intended to be a practical course rather than an exercise in zebrology.

COURSE 306 and COURSE 406

## Wednesday and Thursday

HAROLD G. JACOBSON, M.D. Bronx, New York

STANLEY S. SIEGELMAN, M.D. Baltimore, Maryland

### Skeletal Radiology—Interesting Manifestations, Some Newer Concepts and Provocative Challenges

In these 2 completely new courses a variety of interesting and infrequently encountered skeletal abnormalities will be presented, together with unusual manifestations of more common disorders. These entities will be organized into appropriate categories (e.g., endocrine abnormalities, neoplasms of bone, infective bone lesions, etc.).

Specific subjects will include plasma cell dyscrasias, extra-medullary hematopoiesis, current concepts of hyperparathyroidism, unusual manifestations of skeletal trauma, unusual manifestations of infective bone lesions and some unusual neoplasms of bone (a modern look). In addition, since many

changes in the basic knowledge of protein, calcium and vitamin D metabolism have been advanced in recent years, the radiologist will be brought up to date in regard to the current concepts in these areas. Disorders in these areas with radiological manifestations will be illustrated to reflect this exciting new information.

In each group unusual or even esoteric examples ("mavericks") of that specific entity will be presented, to serve as a springboard for the demonstration of more frequently encountered manifestations of the abnormality under discussion. Newer concepts will be advanced where appropriate.

Participants in these 2 courses will be encouraged to offer diagnostic possibilities (from their seats) for the introductory cases in each category—always on a completely voluntary and anonymous basis, since the room is dark.

The radiological criteria diagnostic for each abnormality (even for the "mavericks" will be discussed, with emphasis directed to the concept that "the answer is always on the film," even in the most difficult of cases.

Skeletal disorders comprise a most fascinating aspect of the discipline of radiology. Sufficient variations exist in each diagnostic category to offer provocative challenges to those interested in testing their skills. Since the learning process is closely related to *challenge* it is anticipated hopefully in these 2 courses, that the case material will be sufficiently stimulating and the gratifications inherent in volunteering the correct diagnosis sufficiently rewarding to ensure a relevant learning experience. In addition, it is hoped that the presentation of newer concepts in important areas will be advantageous.

In any event, no one will be embarrassed because this will not be a quiz show. Hopefully, the courses will demonstrate that learning relating to *challenge* can be fun and that a careful analytic evaluation of the radiological findings generally provide prime consideration of the correct answer, even in unusual instances, since the film usually speaks its own specific language.

## COURSE 307

Wednesday

MAURICE M. REEDER, M.D. Washington, D.C.

BENJAMIN FELSON, M.D. Cincinnati, Ohio

### The Gamut Approach to Radiology

The word gamut is defined as the whole range of anything. As used in a radiological sense, it indicates a complete list of causes of a particular roentgen pattern or finding. Many radiologists have a tendency to use the "Gamut approach" without calling it that. You see a solitary calcification in the skull and im-

mediately start groping in your memory for causes. You recall perhaps 6 causes, then eliminate two because of rarity or incompatible roentgen pattern. Then, with the clinical information at your elbow in the form of an x-ray requisition or a clinician, you weed out two more that do not fit the clinical setting, leaving you with two likely diagnoses, both of which may prove to be incorrect. How frustratingly incomplete these cerebral gamuts really are!

The concept behind the Gamut approach to radiology is to provide you with a more complete and more accurate list of possibilities for a specific pattern such as honeycomb lung, bull's-eye lesion of the gastrointestinal tract, floating teeth, aseptic necrosis, etc. The gamut lists are intended as an unobtrusive consultant quickly available whenever you interpret films or prepare a presentation. In each patient, the possibilities are narrowed down to those that fit the roentgen signs and clinical and laboratory findings. Of course, all the parameters of disturbed morphology and pathophysiology present on the films must be correctly analyzed to identify the appropriate roentgen sign or pattern.

This course will emphasize the importance of a thorough knowledge of gamuts as an essential element of radiographic analysis, alerting the clinician to the various possible etiologies for the specific radiographic abnormality found in his patient. Fifteen representative gamuts covering bone, chest and gastrointestinal tract radiology (and different from those presented in previous years of this course) will be discussed.

### COURSE 308

Wednesday

# A. S. MACMILLAN, JR., M.D. Boston, Massachusetts

### The Temporal Bone

This course covers the temporal bone, the posterior half of the base of the skull or cranial nerves VI-XII. A fundamental knowledge of the anatomy is readily learned through thin section tomography. Plain films, realistically, remain the starting point in the evaluation of this region. Hypocycloidal tomography frequently is carried out in the anteroposterior and lateral planes with fewer in the basal or Stenvers' positions.

Small acoustic nerve tumors  $(\pm 2 \text{ cm.})$  are best studied by posterior fossa pantopaque study. To 99 diphosphonate bone scans may show reactive bone in small lesions. Larger lesions begin with CAT scans and contrast enhancement.

A temporal bone showing little or no periantral air cell development suggests chronic middle ear disease and "keratoma" formation (cholesteatoma). Well pneumatized temporal bones tend to be normal.

Both types, however, may be involved in traumafracture, and by benign and malignant tumors. Anomalies of especial interest are those amenable to corrective surgery.

Arteriography, venography, and PEG's have their place.

### COURSE 309

### Wednesday

# LEONARD E. SWISCHUK, M.D. Galveston, Texas

### Neonatal Chest Problems

The radiologist plays a key role in the diagnosis of neonatal chest disease. His basic job is to determine whether a surgical or medical condition exists, but many times this can be problematic. It is not so much that one is not familiar with such conditions as hyaline membrane disease, TRDN-wet lung syndrome, congenital diaphragmatic hernia, meconium aspiration, etc., but rather that one is often not able to come up with a useful differential diagnosis for certain abnormal roentgenographic patterns. For example: What does one think of when one is presented with: (1) a large, opaque hemithorax; (2) a large, hyperlucent hemithorax; (3) a small, densely opaque hemithorax; (4) a small, slightly opaque hemithorax; (5) bilateral fluffy infiltrates; (6) bilateral bubbly lungs, small bubbles, large bubbles; (7) bilateral granular lungs; or (8) bilateral parahilar, streaky, congested appearing lungs?

Each disease will be dealt with in enough detail so as to allow differentiation of one from the other, but grouping according to abnormal pattern is the place to start.

## COURSE 310

### Wednesday

### JOSEPH P. WHALEN, M.D. New York, New York

# Radiology of the Abdomen: an Anatomic Approach

This course will first briefly review the anatomy of the abdomen by means of sectional anatomy, stressing the relationship of organ systems. Further, it will discuss how the anatomy reflects the roentgen image in the normal and then how pathologic processes, specifically abdominal tumors and inflammation, alter this normal.

Emphasis will be placed on first localizing the abnormality which in turn leads to a differential diagnosis. The questions then asked are: "Is it normal?" If not, "Where is the abnormality?" Finally, with a knowledge of the localization, "What is the differential diagnosis?"

COURSE 311

### Wednesday

JAMES CHRISTIE, .M.D. Iowa City, Iowa

Brain, Cisternography and the EMI

### COURSE 312

#### Wednesday

# PAUL L. CARSON, Ph.D. Denver, Colorado

### Basic Principles of Ultrasound

The nature of ultrasound propagation in tissue will be discussed, with emphasis being placed on the origin and masking of diagnostic information in ultrasound waves in tissue. Several fundamental, practical and unnecessary limitations of imaging with pulse echoes and other reflected and transmitted ultrasound waves also will receive attention. For example, the types of information and artifacts arising from single and multiple reflections, scattering, phase distortion, dispersion, refraction, mode conversion and absorption will be described as will the effects of the necessarily finite ultrasound beam size or resolution in the diagnosis of small lesions.

### COURSE 313

### Wednesday

# GERALD D. DODD, M.D. Houston, Texas

### Thermography of the Breast

There have been significant improvements in thermographic equipment during the past 6 years. Clinical requirements have been taken into consideration in the development of design parameters, and information concerning tumor thermogenesis, interpretative criteria and the reliability of the technique is gradually accumulating.

The following topics, based upon laboratory and clinical trials of the new types of equipment, will be discussed:

- 1. The development and present status of thermographic equipment with particular reference to clinical requirements
- 2. Normal thermographic patterns of the female breast
- The genesis of abnormal thermographic signals and the heat transfer mechanics involved in the production of an abnormal breast thermogram.
- 4. The accuracy of thermography in the diagnosis of breast cancer with emphasis upon the incidence and causes of false negative and false positive examinations

- 5. The current place of thermography as a screening device
- 6. Pending and future developments in thermographic equipment and interpretative techniques.

## COURSE 314 and COURSE 414

### Wednesday and Thursday

JOHN A. GEHWEILER, JR., M.D. Durham, North Carolina

RAYMOND L. OSBORNE, JR., M.D. New York, New York

## The Radiology of Vertebral Trauma: Part I and Part II

We live in an age of injury, an age of trauma. Fractures, luxations and associated soft tissue injuries of the musculoskeletal system now account for over two-thirds of the injuries observed.

In this 2 part course we will consider injuries of the vertebral column. Cases will be analyzed as to the problems of differential diagnosis; gross morphology of the vertebrae and the related joints and ligaments; mechanisms of injury and the expected roentgen patterns. This course will cover the following selected topics:

## Part I-The Cervical Spine

- A. General Principles
  - 1. Classification of fractures
  - 2. Descriptive terms relating to fractures
  - 3. Classification of joint injuries
  - 4. Descriptive terms relating to luxations
  - 5. Classification of cervical spine injuries
    - a. Definition of terms
    - b. Flexion injuries
    - c. Extension injuries
    - d. Vertical compression injuries
    - e. Lateral flexion injuries
    - f. Rotational injuries
    - g. Combined injuries
- B. The Upper Cervical Spine (Atlas and Axis)
  - 1. Atlanto-occipital luxation
  - 2. Atlanto-axial luxation
  - 3. Fractures of the atlas
    - a. Posterior arch
    - b. Anterior arch
    - c. Jefferson fracture
    - d. Miscellaneous
  - 4. Fractures of the axis
    - a. The dens
    - b. Body of the axis
    - c. Vertebral arch

### C. The Lower Cervical Spine

- 1. Flexion injuries
  - a. Hyperflexion sprain
  - b. Hyperflexion luxation
  - c. Hyperflexion fracture luxation
- 2. Extension injuries
  - a. Hyperextension sprain
  - b. Hyperextension compression
  - c. Hyperextension fracture luxation
- 3. Vertical compression injuries
- 4. Lateral flexion injuries
- 5. Rotational injuries
- 6. Combined injuries
- 7. Miscellaneous injuries

## Part II—The Thoracolumbar and Sacrococcygeal Spine

- A. Trauma to the Thoracolumbar Spine
  - Injuries involving the vertebral bodies and disks alone
    - a. Anterior wedge compression fractures
    - b. Kümmell's disease
    - c. Vertebral edge separations
    - d. Scheuermann's disease
  - 2. Injuries involving the vertebral arches
    - a. Hyperflexion fracture luxation
    - b. Seat belt injuries
    - c. Rotary fracture luxations
    - d. Shear fracture luxations
    - e. Hyperextension fracture luxation
    - f. Isolated vertebral arch fractures
    - g. Fractures of the transverse processes
    - h. Fractures of the spinous processes
- B. Sacrum and Coccyx Fractures
- C. Spondylolysis and Spondylolisthesis
  - 1. Pseudospondylolisthesis
  - 2. Retrospondylolisthesis

### COURSE 315

### Wednesday

NORMAN E. CHASE, M.D. New York, New York

IRWIN I. KRICHEFF, M.D. New York, New York

# The Angiographic Diagnosis of Intracranial Mass Lesions

This course will include a logical approach to the study and differential diagnosis of supratentorial intracranial mass lesions with an analysis of localization by shift, vascular displacements and physiologic changes.

The techniques of angiography and supplemental studies will also be included.

### COURSE 401

### Thursday

## ANTHONY F. LALLI, M.D. Cleveland, Ohio

### Destructive Lesions of the Renal Parenchyma

Among the various disease processes which can result in a loss of functioning renal parenchyma there are pyelonephritis, papillary necrosis, tuberculosis, medullary sponge kidney disease, and renal insult in infancy and childhood. These particular problems will be emphasized in the differential diagnostic consideration of the kidney of diminished size or parenchymal thickness, unusual outline or shape.

Many of these entities involve a focal involvement of the kidney which appears both interesting and a potential common theme, lending some understanding to the roentgen appearance and possible interrelationship of these entities. These aspects will be discussed together with the common roentgen identification emphasizing the urographic appearance. The primary emphasis will be on renal papillary necrosis, its often overlooked presence, its relationship to pyelonephritis and the problems inherent in establishing its diagnosis.

## COURSE 402

### Thursday

## HARLEY C. CARLSON, M.D. Rochester, Minnesota

### The Esophagus

This will be a review of most of the major disease processes which involve the esophagus. Principles of examination with emphasis on fluoroscopy as well as radiography will be reviewed and any special techniques applicable to the separate disease processes will also be covered.

In addition to the characteristic radiographic findings of the various disease processes, emphasis will be placed on pathology, significance of the disease to the patient in terms of morbidity and mortality, and additional procedures which may be used to more precisely define the nature of the disease process.

The discussion will include diverticula, webs, esophagitis with its many variations, esophageal hiatal hernia, achalasia, and benign and malignant neoplasms of the esophagus.

## COURSE 403

### Thursday

# MORTON A. MEYERS, M.D. New York, New York

### Intra-Abdominal Spread of Malignancies

What are the routes of spread of abdominal carci-

noma? What are the anatomic planes, channels and recesses which predispose to spread? How can an understanding of these support the x-ray observations? What are the individual characteristic features which permit the diagnosis of a metastatic lesion? How can direct extension, seeded metastases, and hematogenous metastases be radiologically distinguished? What are the common sites of metastatic involvement? What sites, localization, and changes are typical for each of the 3 pathways of dissemination? What are the localizations and changes which may indicate the most likely site of an occult primary carcinoma? What conditions are intra-abdominal metastases most frequently confused with and what are the differential diagnostic features? How are these observations important to the radiologist in directing the diagnostic search and in determining the most appropriate treatment?

## COURSE 404

### Thursday

# J. SCOTT DUNBAR, M.D. Vancouver, B.C., Canada

### The Small Bowel in Pediatric Radiology

When should the small bowel be examined in the course of a "routine upper G.I. study"? What place does such a study have in the evaluation of abdominal pain in childhood? Does a child with celiac disease need a small bowel study? How specific are the findings in celiac disease, or in the "malabsorption syndrome"? Do all infants have small bowel patterns which look like malabsorption? Are the problems and the x-ray findings related to them in the small bowel the same for infants and children as they are in adults, for the most part? What is a reasonable study of the small bowel in a child?

### COURSE 405

### Thursday

# JOHN E. MARTIN, M.D., F.A.C.R. Houston, Texas

### Mammography

Breast disease is best understood when gross specimens and microhistology are correlated with comparative mammographic images.

The similarities of mammograms and gross specimens will be demonstrated.

Concepts of benign and malignant diseases of the breast will be discussed.

### COURSE 407

### Thursday

# GUY D. POTTER, M.D. New York, New York

## Diagnosis and Differential Diagnosis of Sinus Disease: Inflammatory and Neoplastic

The radiographic diagnosis of sinus disease depends upon a thorough knowledge of the radiographic anatomy of the paranasal sinuses and facial bones, both in routine films and tomograms, and upon a knowledge of the changes that occur with the different pathological processes involving the sinuses and the facial bones.

This course will consist of a detailed review of the normal radiographic anatomy and normal variants that may be encountered.

The various pathological conditions producing radiographic changes will be presented with an emphasis on differential diagnostic points. The differential diagnosis between inflammatory and neoplastic disease will be emphasized because, after all, this is the most important differential of all.

### COURSE 408

### Thursday

### JOHN F. WEIGEN, M.D. Palo Alto, California

### Complications of Urography and Cholegraphy

Optimal use of radiologic studies requires that each be selected for a specific patient on the basis of his diagnostic problem, his physical state, and the hazards of the study for him.

The indications for urography and cholegraphy will be reviewed. Their complications will be discussed emphasizing type of reactions, their incidences, identification of high risk factors, prophylaxis, and treatment.

### COURSE 409

### Thursday

## JOHN W. LANE, M.D. Little Rock, Arkansas

## Thyroid and Heart

This course shall devote approximately one-half of its time to each of the above named subjects.

Thyroid studies in the Nuclear Medicine Department will be covered with the focus being on the practical evaluation of this organ for clinical application. Emphasis shall be placed on the uptake and scan and their variations as to techniques, interpretation and a review of "how we do it." Laboratory studies shall be more cursorily covered mostly from a correlative standpoint. Emphasis shall be on practi-

cal, everyday, Nuclear Medicine with little or no discussion of investigative or esoteric techniques.

The heart discussion shall focus on those studies one will be most likely called upon to perform by referring clinicians. Myocardial studies, dynamic studies, and blood pool evaluations shall all be covered from the standpoint of how best this can be done in a clinical Nuclear Medicine Department of average means. Again, little emphasis shall be placed on the more esoteric procedures requiring unusual equipment or investigative licenses.

### COURSE 410

### Thursday

# WILLIAM M. MC KINNEY, M.D. Winston-Salem, North Carolina

### Neurosonology

The development of radiographic procedures has greatly increased the diagnostic capabilities and fundamental understanding of the nervous system. The development of diagnostic ultrasound has added a new dimension with many techniques reported in the literature. The purpose of this discussion is to briefly review the physical principles of diagnostic ultrasound, instrumentation, historical development of techniques, and current state of the art in diagnostic procedures as they relate to the nervous system.

Since the introduction of echoencephalography in 1955 by Leksell, numerous reports have appeared in the literature. Initial enthusiasm for this technique led to widespread use and abuse. A lack of fundamental understanding, training, poor techniques, and difficulties with interpretation will be discussed. A reliable standardized method will be presented with emphasis on interpretation.

The measurement of ventricular size has increased in its importance as a rapid screening method for hydrocephalus. Methods and results will be discussed.

The ability to measure dynamics using diagnostic ultrasonic techniques has led to an increased understanding of neurophysiology. A brief discussion of the underlying mechanisms and clinical usefulness will be presented.

Recent developments in Doppler imaging of blood velocity and extracranial vessels has increased in importance and in technical development. This technique will be presented to demonstrate current methodology and clinical application.

In summary, neurosonology includes diagnostic techniques for study of the nervous system using diagnostic ultrasound. This presentation will cover the broad range of current techniques.

COURSE 411 and COURSE 509

Thursday and Friday

J. THOMAS PAYNE, Ph.D. Minneapolis, Minnesota

# Physical Principles of Computerized Axial Tomography: Part I

Computerized Axial Tomography (CAT) has become a household term for most neuroradiologists and may well become one for other radiology subspecialties. In this course the development of CAT scanning will be briefly reviewed. The pertinent physics of narrow beam x-ray transmission through patient anatomy will be covered. Performance specifications for CAT units will be analyzed and discussed along with phantom methods of CAT scanner evaluation and quality assurance testing. Finally, the various methods of CAT scanner readout, such as CRT display, TV monitor or hardcopy printout will be discussed for currently available commercial equipment as well as the meaning of the calculated computer numbers (i.e., EMI numbers, ACTA numbers, Delta (A) numbers, etc.).

# EDWIN C. MC CULLOUGH, Ph.D. Minneapolis, Minnesota

## Physical Principles of Computerized Axial Tomography: Part II

In addition to the day-to-day clinical use of computed tomography, investigative studies are being carried out at a number of institutions. With an emphasis on clinical impact the following investigative aspects will be lucidly expounded upon; (a) potential of dual kvp scanning; (b) redisplay options: (c) reconstruction algorithm optimization: (d) technical trade-offs (e.g., water equalization bag); (e) measurement of x-ray attenuation in biological specimens; (f) anthropomorphic phantoms for performance evaluation; (g) statistical analysis of numerical values; and (h) whole body scanning capabilities and complications. In addition, a basic discussion of reconstruction algorithms as they relate to the resultant calculated computer numbers will be covered. Finally, a description and discussion of currently available commercial equipment will be included in this course.

### COURSE 412

Thursday

# NORMAN E. LEEDS, M.D. Bronx, New York

Circulatory Changes During Cerebral Angiography as a Guide to Localization and Diagnosis of Intracranial Space Occupying Lesions

"Abnormalities in circulatory dynamics" such as

delayed filling arteries, delayed filling veins, early filling veins and tumor circulation with and without early filling veins occur in 92 per cent of patients examined via cerebral angiography and are, therefore, most important. Normal circulatory patterns will be discussed and then the various abnormal vascular patterns will be presented as a guide to localization and histologic diagnosis.

Tumor blushes in the common lesions such as glioma, meningioma and metastases will be analyzed in an attempt to point out the differential patterns, so that one may discriminate between these lesions.

The "luxury perfusion syndrome" will be presented and the phenomena explained. The multiple pathologic entities (including infarcts, trauma, inflammatory disease, etc.) that produce this syndrome will be demonstrated, and the radiographic changes that permit differentiating these vascular blushes from tumor will be considered.

The changes in blood vessel walls such as arterial narrowing, arterial irregularity and vasodilatation will be presented and the probable causes and pathogenesis will be discussed.

### COURSE 413

Thursday

# D. GORDON POTTS, M.D. New York, New York

## Pneumoencephalography and Brain Anatomy

Although pneumoencephalography is being performed less frequently than a few years ago, it remains an important study for the diagnosis of avascular brain lesions beyond the resolution computerized tomography. The diagnosis of small and subtle abnormalities during pneumoencephalography depends on our ability to recognize minor alterations of the normal anatomy.

In this course the contraindications and complications of lumbar puncture will be discussed. The various projections (including tomographic sections) that are used during pneumoencephalography will be related to the corresponding brain specimens. The major brain and cord conduction pathways will be briefly discussed.

## COURSE 415

Thursday

# DAVID F. REESE, M.D. Rochester, Minnesota

## Computerized Trans-Axial Tomography

The 3 basic forms of radiologic imaging consist of the screen-film combination, electronic methods as used in the image intensifier, and radioisotope organ visualization. To these, computerized trans-axial tomography (CTT) must now be added.

This course will deal with an experience of 2,000

scans made by the EMI scanner. The mechanics of the machine will be covered; neuroanatomy in the transverse axial projection will be explained and correlated with the computer displays.

Our clinical experience with tumors, trauma and degenerative lesions will be presented and the impact of the method on the more conventional neuroradiologic diagnostic techniques will be discussed.

### COURSE 501

### Friday

## FRANCIS F. RUZICKA, M.D. Madison, Wisconsin

### Normal Vascular Anatomy of the Gastrointestinal Tract and Related Organs

This course is designed first to present in simplified form the prevailing patterns of variations of the visceral arteries. In addition to the variations of the major trunks, the arteries of the liver, gallbladder, pancreas, spleen and gastrointestinal tract will be discussed in detail. Further, major collateral routes that involve the visceral arteries will be illustrated: (1) the vertical pathways between the celiac and superior mesenteric artery systems; (2) the vertical pathways between the superior mesenteric and the inferior mesenteric artery systems; and (3) the horizontal collateral routes between the right and left sides of the celiac artery system.

Secondly, the predominate normal portal venous pattern and the more common variations as seen radiologically will be described and illustrated.

Thirdly, test cases will be presented for audience participation for the sake of repetitive instruction.

## COURSE 502

## Friday

## JEREMY J. KAYE, M.D. New York, New York

## Arthrography of the Knee

The course is designed to present both the beginner and the experienced arthrographer with the techniques to perform and the knowledge to interpret knee arthrograms. Illustrative material is drawn from experience with more than 15,000 arthrograms of the knee. Topics to be covered will include:

- 1. A brief historical review
- 2. The indications and contraindications
- 3. The anatomy pertinent to knee arthrography
- 4. Detailed descriptions of techniques
  - a. Fluoroscopic technique
  - b. The horizontal beam technique

- 5. Normal arthrogram
- 6. Abnormal knee arthrograms
  - a. Meniscal abnormalities
  - b. Articular cartilage lesions
  - c. Ligamentous injuries and capsular tears
  - d. Synovial abnormalities
- 7. Subtleties and fine points in interpretation
- 8. Potential causes of error in interpretation
  - a. Related to technique
  - b. Related to anatomy
- 9. Complications of knee arthrography
- 10. Arthrography and (? vs) arthroscopy
- ii. Conclusions: Why do knee arthrography?

## COURSE 503

### Friday

# PETER G. HERMAN, M.D. Boston, Massachusetts

# B. LEONARD HOLMAN, M.D. Boston Massachusetts

### Pulmonary Thromboembolic Disease

This course will offer a comprehensive review of pulmonary thromboembolic disease including data on incidence, predisposing factors, pathophysiology, diagnostic methodology, treatment and prognosis.

We will emphasize the interpretation of radiographic studies including the correlation of chest radiographs with scintigraphic and angiographic findings. The importance of combined perfusion and ventilation scans will be stressed. We will discuss the unusual manifestations of pulmonary thromboembolic disease in patients with chronic obstructive pulmonary disease and congestive heart failure.

We will present a logical approach to the decision process of selecting appropriate diagnostic tests for patients suspected of having pulmonary thromboembolism.

### COURSE 504

### Friday

# RICHARD H. DAFFNER, M.D. Louisville, Kentucky

### A Logical Approach to Skeletal Radiology

The radiologic interpretation of bone lesions should be performed in a logical manner similar to that used for other organ systems. The purpose of this course is to outline such a system.

Logical analysis begins by defining the distribution of a bone lesion (monostotic, polyostotic, or diffuse). Six pathologic categories, congenital, inflammatory, neoplastic, metabolic, traumatic and vascular may then be integrated with the distribution of the dis-

ease. The differential diagnosis is further narrowed by adding 10 variables which should be sought in every case. These are:

- 1. Behavior of the lesion
- 2. Which bone involved
- 3. Locus within a bone
- 4. Age and sex of patient
- 5. Margin of the lesion
- 6. Is the joint space crossed?
- 7. Bone reaction
- 8. Matrix production
- 9. Presence of a soft tissue mass
- 10. History of trauma

Each of these variables is defined and appropriate examples are shown. In addition, examples will be shown in each pathologic category according to the distribution of lesions.

### COURSE 505

### Friday

## LAWRENCE P. ELLIOTT, M.D. Gainesville, Florida

## A Plain Film Approach to Adult Heart Disease

This is a lecture which stresses the proper sequential approach to the plain chest film of a patient suspected of heart disease. This approach deals with: a technical analysis of the films; (2) extracardiac phase; (3) mediastinal analysis; (4) pulmonary vascularity and lungs; and (5) cardiac anatomy. It will be shown that the cardiac chambers and vessels have a priority of importance depending upon the type of pulmonary vascular pattern. Emphasis will be placed on adults presenting with pulmonary venous congestion secondary to rheumatic mitral valve disease and various conditions causing left ventricular failure.

### COURSE 506

### Friday

# ROBERT L. EGAN, M.D. Atlanta, Georgia

### **Detection of Early Breast Cancer**

A review of mammography, and other modalities it has engendered, and the study of breast diseases will be presented. The value of mammography, its pitfalls and how to obtain the most from the procedure will be stressed. Also frankly discussed will be mammographic equipment, radiographic detail and dosage, compression, screen-film combinations, processing, collimation and requirements for an occasional as well as a busy mammographic room. If desired, discussion can extend into thermography and modified radiographic techniques for breast examination.

### COURSE 507

### Friday

## MERLE K. LOKEN, M.D., Ph.D. Minneapolis, Minnesota

## Radioisotopic Techniques for Evaluating the Lung

During the past decade, much attention has been focused on the use of radioactive isotopes in evaluating pulmonary disease. Scintiphotography of the lungs following the intravenous administration of labeled microaggregated or microspheric albumin has become an accepted technique for studying patients with suspected pulmonary emboli. A variety of radioactive aerosols that, when inhaled, give an indication of bronchial patency and aerated space, also have received considerable attention.

Radioactive oxygen, nitrogen, carbon dioxide, krypton, and xenon are among the radioactive gases used to measure pulmonary ventilation and perfusion. The half-life of the gamma emitting oxygen, nitrogen and carbon radioisotopes is extremely short, requiring a close proximity between the cyclotron used for their production and the pulmonary function laboratory. Thus, attention has been focused on the use of xenon 133, which is universally available and has acceptable, although not ideal, physical characteristics. At the present time, attention is being given to another isotope of xenon, xenon 127, which has better physical characteristics.

Several investigators have reported on the use of transmission scintiphotography as an indicator of lung function. With this technique, a picture is obtained by use of an external source of gamma rays transmitted through the patient (analogous to a chest roentgenogram). We have not found this technique particularly useful for this purpose, but have used it in conjunction with blood pool studies to evaluate pericardial effusions and, together with the liver scan, to detect subphrenic abscesses. Other techniques that have been investigated include measurements of lung water, ciliary action, and pulmonary diffusing capacity; however, these are research techniques rather than routine clinical tests, and only brief mention will be made of them during this presentation.

### COURSE 508

Friday

# MICHAEL JOHNSON, M.D. Durham, North Carolina

### Diagnostic Echocardiography

Echocardiography has become an extremely useful diagnostic tool in the evaluation of patients with cardiovascular disease. It is non-invasive, accurate and can be performed repeatedly for serial evaluation. Echocardiography is diagnostic in many cardiac abnormalities including pericardial effusion, mitral stenosis, prolapsing mitral valve, IHSS, left ventricular outflow tract lesions, and left atrial tumors. It is useful in determining ventricular chamber size and function, and in the detection of aortic stenosis, aortic insufficiency, bacterial vegetations, and many congenital cardiac abnormalities.

The echocardiographic findings in normal and diseased states will be presented. Interesting cases will be shown for group discussion. Newer techniques, such as real time, two-dimensional, cross-sectional imaging of the heart will be discussed.

### COURSE 510

Friday

## A. L. WEBER, M.D. Boston, Massachusetts

## Radiological Evaluation of Eye and Orbital Lesions

This course will deal with radiological evaluation of eye and orbital lesions. Different radiologic examinations, such as plain films, polytomography, venography, angiography, ultrasound, CAT-scan, and dacryocystography, will be discussed, with respect to eye and orbital lesions. After a brief review of the normal orbital anatomy, different topics, including trauma (with major emphasis on blow-out fractures) and the causes and findings in exophthalamos, will be discussed. Examples of lesions arising from the eye and orbit or extending into the orbit from the cranial cavity, facial area, and sinuses will be shown, with a discussion of the radiological findings.



## CONDENSED SCHEDULE OF COURSES

SUNDAY

1:00 to 5:00 P.M.

September 28, 1975

# Categorical Course on Chest Six Sessions—16 Hours Begins Sunday—Continues Through Friday

For more detailed Information see course description, Faculty List, time of daily lectures, and rules of registration on preceding pages.

The Fee for this 16 hour course is \$25.00 and registration in this course precludes registration in any of the other courses listed on following pages. Members as well as guests must pay the fee for this course.

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CONDENSED SCHEDULE OF COURSES				
MONDAY 3:00 to 4	:30 P.M. September 29, 1975			
General Diagnosis	Nuclear Medicine: Ultrasound: Physics: Neuroradiology			
IOI—Hartman Excretory Urography—Individualization of the Examination	ro6—Saenger Wilkinson Bone Scanning; Tumor Localization Radiopharmaceuticals			
ro2—Rice Radiologic Evaluation of the Acute Abdomen	107—Goldberg An Introduction to Diagnostic Ultrasound			
103—Edeiken A Rational Approach to Bone Radiology	108—Kattan Tricks and Treats in Tomography			
104—Chait Abdominal Angiography—Part I	109—Schechter Marc A Simplified Approach to Posterior Fossa			
105—Wolfe Xeroradiography	(Vertebral) Angiography			

### CONDENSED SCHEDULE OF COURSES

TUESDAY

3:00 to 4:30 P.M.

September 30, 1975

## General Diagnosis

### 201-Friedenberg

Non-Neoplastic Lesions of Kidney and Ureter

### 202-Marshak

Lesions of the Colon: A Pathologic and Roentgen Correlation

### 203-Martel

Differential Diagnosis of Arthritis

## 204—Chait

Abdominal Angiography—Part II

### 205-Wolfe

Mammography-Part I

## 206-Baker

### Berdon

Varied and Unusual Sequelae in Both Systemic and Primary Bone Disease in Children

## 207-Graham

Persistent Myths which Confuse and Complicate Children's Radiology

## 208-Macmillan

Sinuses and Orbits-The Facial Region

# Nuclear Medicine: Ultrasound: Physics: Neuroradiology

### 200-McConnell

### Staab

Nuclear Medicine—Liver Nuclear Medicine—Kidney

### 210-Leopold

Abdominal Ultrasonography

### 211-Hendee

Physics: Innovations in Diagnostic Radiology

### 212-Judkins

Imaging Techniques and Equipment Requirements for Cinefluorography

## 213-Gold

A Simplified Approach to Posterior Fossa Angiography

### 214-Harwood-Nash

The Pediatric Spine and Myelography

## 215-Chase

### Kricheff

Computerized Axial Tomography

CONDENSED SCHE	DULE OF COURSES
WEDNESDAY 3:00 to 4	1:30 P.M. October 1, 1975
General Diagnosis	Nuclear Medicine: Ultrasound: Physics: Neuroradiology
301—Thornbury Renal Cystic Disease in Adults and Children	311—Christie Nuclear Medicine: Brain Scanning; Scinti- Cisternography and Computerized Axial Tomography
302—Marshak The Small Intestine	312—Carson Basic Principles of Ultrasound
303—Ozonoff Disorders of the Hip in Children	313—Dodd Thermography of the Breast
304—Wesenberg The Avant-Garde Approach to the Newborn Chest	314—Gehweiler Osborne The Radiology of Vertebral Trauma
305—Wolfe Mammography—Part II	Part I
306—Jacobson Siegelman Skeletal Radiology—Interesting Manifestations, Some Newer Concepts and Provocative Challenges—Part I	315—Chase  Kricheff  The Angiographic Diagnosis of Intracranial Mass Lesions
307—Reeder Felson The Gamut Approach to Radiology	
308—Macmillan The Temporal Bone	
309—Swischuk Neonatal Chest Problems	
310—Whalen Radiology of the Abdomen	

	CONDENSED SCHE	DULE OF COURSES
THU	JRSDAY 3:00 to 2	:30 P.M. October 2, 1975
	General Diagnosis	Nuclear Medicine: Ultrasound: Physics: Neuroradiology
401-	-Lalli Destructive Lesions of the Renal Parenchyma	409—Lane Nuclear Medicine: Thyroid and Heart
402-	-Carlson The Esophagus	Neurosonology
403-	-Meyers Intra-Abdominal Spread of Malignancies	Physical Principles of Computerized Axial Tomography—Part I
404-	<b>-Dunbar</b> The Small Bowel in Pediatric Radiology	412—Leeds Circulatory Changes During Cerebral Angiography: A Guide to Localization
405-	<b>–Martin</b> Mammography	and Diagnosis of Intracranial Space Occupying Lesions
406-	-Jacobson Siegelman Skeletal Radiology-Interesting Mani-	413—Potts Pneumoencephalography and Brain Anatomy
	festations, Some Newer Concepts and Provocative Challenges—Part II	414—Gehweiler Osborne
407-	-Potter Diagnosis and Differential Diagnosis of Sinus Disease: Inflammatory and Neo-	The Radiology of Vertebral Trauma Part II
ļ	plastic	415—Reese Computerized Trans-Axial Tomography
408-	-Weigen Complications of Urography and Choleg- raphy	- I Shiputoned Time Tamography

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	CONDENSED SCHE	DULE OF COURSES		
FRIDAY	11:A.M. to	12:30 P.M.	October 3, 1975	
General Diagnosis		Nuclear Medicine: Ultrasound: Physics: Neuroradiology		
	Vascular Anatomy of the Gastro- al Tract and Related Organs	507—Loken Radioisotopic Techr the Lung	iques for Evaluating	
502—Kaye Arthrog	raphy of the Knee	508—Johnson Diagnostic Echocard	liography	
503—Herman Holman Pulmon		509—McCullough Physical Principles o Tomography—Part	f Computerized Axial II	
504—Daffner A Logic	al Approach to Skeletal Radiology	510-Weber Radiological Evalua	tion of Eye and Orbi-	
505—Elliott Plain I Disease	Film Approach to Adult Heart	tai Lesions	*	
506—Egan Détection	on of Early Breast Cancer		•	

# SECTION ON INSTRUCTION ORDER SHEET

It is important to register for the Instruction Courses as early as possible since the number admitted to each course will be limited. It is also very important that first, second and third choices be listed for each period. All orders for tickets will be filled according to the postmark on the envelopes.

Nonmembers of the American Roentgen Ray Society will pay \$3.00 for each course-period. Nonmembers' fees must accompany this Order Sheet and will not be returned unless cancellation is received before September 20,

Members of the American Roentgen Ray Society, residents in Radiology, and nonmembers who are contributing to the program, either by way of an instruction course, a paper or a scientific exhibit, are not required to pay for these courses but must fill out these Pink Order Sheets, indicating their choices.

Tickets for courses will be mailed to each registrant whose order reaches the office of the Director on or before September 19, 1975. They will be sent to the address below unless registrant directs otherwise.

Please fill out	the following (type or print):		∫□ Member
Last Name	First Name or Initials		☐ Guest
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	treet Address	Check	☐ Resident in Radiology at:
	State Zip Code		Scientific Exhibitor/Paper

Those whose advance registration reaches the office of the Director after September 19, 1975 may obtain their tickets at the Registration Desk of the Section on Instruction on Sunday morning, September 28 and thereafter. At this time tickets may also be obtained for courses not sold out.

## CATEGORICAL COURSE ON CHEST

16 hours over ( Fee: \$25.00 me	6 day period, Sunday through Friday. embers and nonmembers alike (includes syllabus)
Check enclo	osed
	Signature
DO NOT FILL OU COURSE. SYLLABU	T FORM BELOW IF YOU HAVE SELECTED THE CATEGORICAL CHEST IS available at registration desk on presentation of course ticket.

For convenience in selecting your courses consult the condensed schedule of courses.

## BE SURE TO FILL OUT SECOND AND THIRD CHOICES FOR EACH PERIOD

	First Choice		Sec	Second Choice		Third Choice	
Period	Course No.	Instructor	Course No.	Instructor	Course No.	Instructor	
Monday							
Tuesday							
Wednesday							
Thursday		ally.					
Friday							

Send this order to:
DR. HAROLD O. PETERSON, 1995 West County Road "B", St. Paul, MN 55113
OR if you are mailing late, send to:
DR. HAROLD O. PETERSON, Atlanta Marriott,
Courtland and Cain Sts.,
Atlanta, GA 30303

## **NEWS ITEMS**

# NEW OFFICERS OF THE AMERICAN COLLEGE OF RADIOLOGY (ACR)

At the recent annual meeting of the American College of Radiology the following officers were elected: President, Robert E. Wise, M.D., Boston, Massachusetts; Vice President, Harold N. Schwinger, M.D., Brooklyn, New York; Secretary-Treasurer, Newton Hornick, M.D., Pittsburgh, Pa.; Chairman of the Board of Chancellors, John M. Dennis, M.D., Baltimore, Maryland; Vice-Chairman of the Board of Chancellors, Fredric D. Lake, Chicago, Illinois; Chairman of the ACR Board of Chancellors: Dr. Wise will serve until the next Annual Meeting in Washington. Fifty-third Annual Meeting: March 29-April 2, 1976, Washington, D.C.

# A COURSE IN PHYSICS RELATED TO THERAPEUTIC RADIOLOGY

The University of Texas System Cancer Center M. D. Anderson Hospital and Tumor Institute at Houston announces a special course in high energy electron, x-ray and neutron dosimetry.

The deadline for application is June 23,

For application form, please write to: The University of Texas, Health Science Center at Houston, Division of Continuing Education, P.O. Box 20367, Houston, Texas 77025.

### PATHOLOGY AND RADIOLOGY OF BONE AND JOINT DISEASE PROGRAM OFFERED BY UCLA EXTENSION

A new course titled "The Pathology and Radiology of Bone and Joint Diseases" will be offered by UCLA Extension's Department of Health Sciences on August 11 to 15, Monday through Friday, at the University of California Residential Conference Center, Lake Arrowhead, California, according to program chairman Joseph M. Mirra.

For additional information, please write to: Health Sciences, UCLA Extension, P.O. Box 24902, Los Angeles, California 90024 or call (213)825-8154.

## DIAGNOSTIC ULTRASOUND IN OBSTETRICS AND GYNECOLOGY

Thursday and Friday, September 11 and 12, 1975, The Johns Hopkins Hospital, Baltimore, Maryland, will give a comprehensive course on the value of diagnostic ultrasound as applied to obstetrics and gynecology.

The faculty, which includes Drs. Barry Goldberg, Wayne Johnson, Donald Latham King, Murray Miskin, Lajos Von Micsky, Marvin Ziskind, Judith Rose, Melvyn Conrad, Louis Hellman, Theodore King, Jennifer Niebyl, and Roger Sanders, has been selected for its outstanding contribution to the field of gynecologic ultrasound.

Fourteen hours of AMA Category 1 accreditation is available.

Details can be obtained from: Ms. D. Magner, Department of Radiology, The Johns Hopkins Hospital, Baltimore, Maryland 21205.

### SYMPOSIUM ON POLYTOMOGRAPHY OF THE TEMPORAL BONE

The 12th two day Symposium on Polytomography of the Temporal Bone will be given under the auspices of The Wright Institute of Otology at Community Hospital, Indianapolis, Indiana on September 27 and 28, 1975.

The course is accredited for the AMA Physician's Recognition Award (PRA).

Subjects to be covered are: "Basic Anatomy of the Temporal Bone" and "Technique of Polytomography of the Temporal Bone" with demonstrations of normal tomograms. Pathological conditions revealed by polytomography, such as cholesteatoma, ossicular chain problems, otosclerosis, fractures, foreign bodies, tumors, and congenital anomalies are to be shown on original tomograms and the clinical applications discussed.

The number of registrants is limited to 18.

Inquiries should be directed to: The Wright Institute of Otology, Inc., Community Hospital of Indianapolis, Inc., 1500 North Ritter Avenue, Indianapolis, Indiana 46219.

### TUMOR DIAGNOSIS PROCEDURES, FOCUS OF UCLA EXTENSION PROGRAM

"New Scintigraphic Procedures for Tumor Diagnosis," a postgraduate continuing education course designed for physicians and nuclear medicine technologists concerned with the correct use of nuclear medicine procedures for tumor localization, will be offered by UCLA Extension this fall.

Scheduled for September 27 and 28, from 8:30 A.M. to 5 P.M. Saturday and 9 A.M. to 12:30 P.M. Sunday at UCLA's Neuropsychiatric Institute Auditorium, the program will explore the use of radionuclides to localize tumors, from the earliest applications of radionuclides in medicine to the new instrumentation and radiopharmacy which have rejuvenated the field of oncologic nuclear medicine.

Speakers for the seminar will be Dr. L. Stephen Graham, Dr. Ramesh C. Verma, Dr. Alan Waxman, Dr. William H. Blahd, Dr. Charles Haskell, Dr. Robert E. O'Mara and Dr. Henry Wagner, Jr. Chairmen will be Dr. Juan J. Touya and Dr. Leslie R. Bennett.

For more information, please write: Department of Health Sciences, UCLA Extension, P.O. Box 24902, Los Angeles, California 90024 or call (213)825-5840.

# SYMPOSIUM ON GENERAL DIAGNOSTIC RADIOLOGY

The Department of Diagnostic Radiology at the Lahey Clinic Foundation announces a Symposium on General Diagnostic Radiology to be held at the Copley Plaza Hotel, Boston, Massachusetts on September 12 and 13, 1975.

Fourteen hours Category I Credit is given by the AMA for this symposium.

For further information, please contact:

Carl R. Larsen, M.D., Program Chairman, Department of Radiology, Lahey Clinic Foundation, 605 Commonwealth Avenue, Boston, Massachusetts 02215.

# PROBLEMS IN PEDIATRIC RADIOLOGY: CLINICAL RADIOLOGIC CORRELATION

The Jaundiced Infant, Neonatal Abdominal Distention, The "Cystic" Lung, Solid Tumors in the Pediatric Patient, Obstructive Uropathies, Trauma:

A Logical Approach To Diagnosis and Treatment

This Seminar is arranged by the Department of Radiology, University of Miami School of Medicine at the Doral Country Club and Hotel, Miami, Florida, October 8–12, 1975.

This course is approved for 12 hours of instruction in Category 1 of the AMA Council on Continuing Medical Education.

The Faculty consists of Walter E. Berdon, M.D., New York, New York; Donald M. Buckner, M.D., Miami, Florida; Marie A. Capitano, M.D., Philadelphia, Pennsylvania; William W. Cleveland, M.D., Miami, Florida; N. Thorne Griscom, M.D., Boston, Massachusetts; James R. Le Page, M.D., Miami, Florida; August Miale, Jr., M.D., Miami, Florida; Catherine A. Poole, M.D., Miami, Florida; Marc I. Rowe, M.D., Miami, Florida; Manuel Viamonte, Jr., M.D., Miami, Florida; and Howard A. Wexler, M.D., Miami, Florida.

The format of this Seminar will consist of 6 sessions, each a 90 minute in-depth evaluation of a controversial or problem area in Pediatric Radiology. The topics will be introduced by featured speakers, in each instance a Radiologist, to be followed by a panel discussion by additional Radiologists, Pediatricians and/or Pediatric Surgeons. Illustrative cases will be available for audience viewing prior to each session, and audience participation in the panel discussions will be invited.

For further information, please write to: The Department of Radiology, University of Miami School of Medicine, Greater Miami, Florida.

## GENERAL DIAGNOSTIC RADIOLOGY

New York University Post Graduate Medical School will give a postgraduate course in General Diagnostic Radiology, October 13–17, 1975.

This 5 day course will include a survey of all sub-specialties of diagnostic radiology including nuclear medicine and ultrasonography. It is designed as a refresher for the practicing radiologist, and to help prepare the candidate for boards in radiology. Basic concepts will be stressed but special attention will be given to new developments in the field of diagnostic radiology.

The course will be held at the Biltmore Hotel and is structured as follows: Monday, October 13, Uroradiology; Tuesday, October 14, Gastrointestinal Radiology; Wednesday, October 15, Chest and Cardiac Radiology; Thursday, October 16, Bone and Joint Radiology; Friday, October 17, Neuroradiology.

Radiologists from New York University Post-Graduate Medical School, as well as a distinguished guest faculty, will participate.

A detailed brochure of the course program will be available in August. Owing to space limitations, early registration is advised.

Preregistration form (Course 651) is available at NYU Post-Graduate Medical School, Office of the Recorder—Room 4-44N LHB, 550 First Avenue, New York, New York 10016.

# FIRST CANADIAN CONFERENCE ON MEDICAL DEVICES IN HEALTH PROTECTION

To commemorate the centennial of the introduction of legislation pertaining to the safety of food and drugs in Canada, the Health Protection Branch, Department of National Health and Welfare and the Canadian Association of Manufacturers of Medical Devices will jointly host The First Canadian Conference on Medical Devices in Health Protection.

It will be held in the Government Conference Centre, Ottawa, Canada on October 20–22, 1975. Registration is limited to 400.

There will be simultaneous translation for the official conference languages, English and French. A ladies' program will be arranged.

For further information, please write or call: Dr. A. K. DasGupta, Director, Bureau of Medical Devices, Health Protection Branch, Department of National Health and Welfare, Ottawa, Ontario, K1A oL2. Telephone: (613)996-8983.

## XIV CONGRESSO INTERNACIONAL DE RADIOLOGIA

Patrocínio: Colégio Brasileiro De Radiologia

In the name of Professor Nicola Caminha, President Elect of the XIV International Congress of Radiology, I have the pleasure to invite radiologists throughout the world to attend a meeting at Rio de Janeiro, October 23–29, 1977. The most recent topics of interest to radiology will be discussed and the most advanced technical improvements in the industry of radiological equipment will be shown, while we shall enjoy the pleasure of your company.

The month of October in Brazil (103 million inhabitants and an area of  $8\frac{1}{2}$  million square kilometers) is the season of Spring. As Brazil is situated to its greatest extent south of the equator, the seasons of the year are opposite to those of the northern hemisphere: Winter begins on June 21st. In the tropics there is little variation in temperature: in Rio de Janeiro the average Winter temperature is about 21°C (70°F.), while the average in Summer is about 25°C. (77°F.).

An extensive and varied social program is being organized including a small Brazilian-style Carnival, to benefit, as much as possible, the preferences of our visitors.

As regards the scientific program, this is being organized with the assistance of our special Committee, as well as by consultation with a considerable number of outstanding specialists from all over the world. We hope that this up-to-date scientific program arouses the interest of all radiologists who will visit us. Your personal suggestions in regard to subjects will be most welcome,

as long as these suggestions arrive soon so that they may be carefully considered.

While this notice contains only preliminary information, we would appreciate it very much if you would kindly inform us as to whether or not you intend to be present at the Congress so that we may take the necessary steps regarding hotel accommodations and the social program.

Please write to: Durval Couto, Secretary General, Sociedade Brasileira de Radiologia, Av. Churchill, 97-5° and -ZC-39, 20.000—Rio De Janeiro, Brasil.

# POSTGRADUATE COURSE IN NEURORADIOLOGY

There will be a Postgraduate Course in Neuroradiology sponsored by Dr. Juan M. Taveras and Dr. Paul F. J. New of the Massachusetts General Hospital and Harvard Medical School from October 20–23, 1075

This 4 day course will cover most topics in the field of Neuroradiology with approximately half the course being devoted to a symposium on standard and computer assisted tomography, including transmission (EMI Scanner) and emission (radionuclide) techniques.

The faculty will consist of neuroradiologists from the United States, Canada, Europe including Scandinavia.

Please send inquiries to: Harvard Medical School, Department of Continuing Education, 25 Shattuck Street, Boston, Massachusetts 02115.



## **BOOK REVIEWS**

RADIOLOGY OF BONE DISEASES. Second edition. By George B. Greenfield, M.D., Chairman, Department of Radiology, Mount Sinai Hospital Medical Center, Chicago, Ill.; Attending Radiologist, Cook County Hospital and The Hektoen Institute for Medical Research at Cook County Hospital, Chicago, Ill.; Professor of Radiology, Cook County Graduate School of Medicine, Chicago, Ill.; and Consultant Radiologist, Hines Veterans Administration Hospital, Hines, Ill. Cloth. Pp. 667, with 1,100 illustrations. Price, \$50.00. J. B. Lippincott Company, East Washington Square, Philadelphia, Pa. 19105, 1975.

This is the second edition of a book, the first edition of which was reviewed here in August, 1970. It still eminently fulfills the three-fold purpose originally essayed. In this large book, diseases are grouped according to their roentgen characteristics, and the diagnosis of bone diseases is approached analytically. These have not changed in this second edition. The third declared purpose, unifying the widely scattered information which has appeared in the radiologic literature, has been greatly furthered by extensive additions from the literature of the past 5 years. In some chapters the references have been more than doubled in number.

The illustrations are large, clear, and well reproduced. They have been increased by about 30 per cent over the first edition. Much new material has been added as a result of new understanding of physiology in relation to metabolic bone disease. An entire chapter on the radiologic aspects of arthritis has been added to this edition. The volume has 50 per cent more pages than before.

Because the roentgen characteristics are treated analytically, feature by feature, tables of differential diagnosis are prominent in the text. This leads to the rational approach to diagnosis rather than pattern recognition. Enough clinical information is given to permit completion of the diagnostic process; but the longer, detailed descriptions of disease are found among the long lists of references.

The book is practical, useful, and highly recommended for anyone interested in roent-genograms of the skeleton.

E. Frederick Lang, M.D.

THE YEAR BOOK OF DIAGNOSTIC RADIOLOGY, 1975. Edited by Walter M. Whitehouse, M.D. Associate Editors: Joseph J. Bookstein, M.D., Trygve O. Gabrielsen, M.D., John F. Holt, M.D., William Martel, M.D., John R. Thornbury, M.D., and Alan H. Wolson, M.D. Cloth. Pp. 479, with many illustrations. Price, \$21.50. Year Book Medical Publishers, 35 East Wacker Drive, Chicago, Ill. 60601, 1975.

The 1975 Yearbook of Diagnostic Radiology has not only received a new cover and title but a more comprehensive selection of articles for review than ever before in its 44 year history. This was made possible by moving the section on radiation therapy to the Year Book of Cancer, thereby allowing many more reviews in the diagnostic field.

The Editor, Dr. Whitehouse, readily admits that many articles of broad interest are not easily abstracted and must be read in the original. But the articles covered in these 459 pages represent the most significant in the world radiological literature during the past year, and there is enough detail in each abstract to allow for enjoyable reading. Seldom would one have to go to the original article unless it was to be used for additional medical writing.

Even if one attends one or two national or regional conventions and a refresher course each year, it is difficult to keep abreast of the rapidly advancing innovations in the field of diagnostic radiology. In this respect this text is a valuable addition to the usual journals to which one usually subscribes. A subject of recent interest concerning computerized axial tomography is well documented. A new chapter on Ultrasound has been included since this modality has been placed in our hands as a diagnostic adjunct. Angiography continues to be well represented by a host of articles which show that almost every organ and structure is accessible to the catheter's probing tip. Several studies on disseminated intravascular coagulation were of particular interest. As usual, the editorial references and comments were apropos, and the radiographic reproductions were excellent although small. No radiologist's library should be without this Year Book.

Arch H. Hall, M.D.

### BOOKS RECEIVED

ATLAS OF ROENTGENOGRAPHIC POSITIONS AND STANDARD RADIOLOGIC PROCEDURES. By Vinita Merril. Fourth Edition. In Three Volumes. Cloth. Pp. 1,030, plus indices, with many illustrations. Price, \$60.00. C. V. Mosby Company, 3301 Washington Boulevard, St. Louis, Mo. 63103, 1975.

Basic Nuclear Medicine. By Sheldon Baum, M.D., Associate Professor of Radiology (Nuclear Medicine) and Assistant Professor of Medicine, New York Medical College, New York, N. Y.; and Roland Bramlet, Ph.D., Chief Physicist, Rochester General Hospital, Rochester, N. Y. Cloth. Pp. 270, with many illustrations. Appleton-Century-Crofts, 292 Madison Avenue, New York, N. Y. 10017, 1975.

TUMORS OF THE NERVOUS SYSTEM. Edited by H. Gunter Seydel, M.D., M.S., Associate Professor of

Radiation Therapy and Nuclear Medicine, The Jefferson Medical College of the Thomas Jefferson University, Philadelphia, Pa.; Chief, Department of Radiation Therapy, American Oncologic Hospital of the Fox Chase Cancer Center, Philadelphia, Pa. Proceedings of the Fourth Annual Symposium of the American Oncologic Hospital of the Fox Chase Cancer Center. Cloth. Pp. 193, with some illustrations. John Wiley & Sons Inc., 1 Wiley Drive, Somerset, N. J. 08873, 1975.

Gastrointestinal Radiology in Pediatrics. By Edmund A. Franken, Jr., M.D., Associate Professor, Department of Radiology, Indiana University School of Medicine; Director of Radiology, James Whitcomb Riley Hospital for Children, Indianapolis, Ind. Cloth. Pp. 337, with 574 illustrations. Price, \$27.50. Harper & Row, Publishers, Inc., 2350 Virginia Avenue, Hagerstown, Md. 21740, 1975.



## SOCIETY PROCEEDINGS

## MEETINGS OF RADIOLOGICAL SOCIETIES\*

### United States of America

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. James Franklin Martin, 300 S. Hawthorne Rd., Winston-Salem, N. C. 27103. Annual Meeting: Marriott Hotel, Atlanta, Ga., Sept. 30-Oct. 3, 1975.

AMERICAN RADIUM SOCIETY Secretary, Richard H. Jesse, Dept. of Surgery, M. D. Anderson Hosp. and Tumor Institute, Houston, Tex. 77025. Annual Meeting: Americana Hotel, San Juan, Puerto Rico, May 4-9, 1975.
Rădiological Society of North America

Secretary, Dr. Theodore A. Tristan, Harrisburg, Pennsylvania. Annual Meeting: McCormick Place on the Lake, Chicago, Ill., Nov. 30-Dec. 5, 1975.

American College of Radiology

Executive Director, William C. Stronach, 20 N. Wacker Drive, Chicago, Ill. 60606. Annual meeting: Portland-

Hilton Hotel, Portland, Oregon, March 31-April 4, 1975.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION Secretary, Dr. Antolin Raventos, Davis, Calif. Annual Meeting: Atlantic City, N. J., June 15-19, 1975. AMERICAN BOARD OF RADIOLOGY

Secretary, Dr. C. Allen Good. Correspondence should be directed to Kahler East, Rochester, Minn. 55901.

Written Examination will be held in 14 selected sites,

Oral examinations will be held: Pittsburgh Hilton, Oral examinations will be neid: FITTSDUTGH FITHTON, Pittsburgh, Pa., June 2-7, 1975; Statler Hilton, Dallas, Texas, Dec. 8-13, 1975; Marriott Motor Hotel, Chicago, Ill., June 14-19, 1976; Sheraton Biltmore, Atlanta, Ga., Dec. 6-11, 1976.

Applications must be received in the Board Office

before Sept. 30 of the year preceding the one in which the candidate wishes to be examined.

Deadline for filing applications for any examination in

1976 is September 30, 1975. American Board of Nuclear Medicine, Inc. A Conjoint Board of the American Boards of Internal Medicine, Pathology and Radiology and sponsored by the Society of Nuclear Medicine.

Application forms and further information are available from the American Board of Nuclear Medicine, 305 E. 45th St., New York, N. Y. 10017.

Merican Association of Physicists in Medicine Secretary, Dr. Robert G. Waggener, Dept. Radiol., Univ. Tex. Health Sciences Center, San Antonio, Tex. 78284.

Annual Meeting, Aug. 3-7, 1975.
AMERICAN SOCIETY OF THERAPEUTIC RADIOLOGISTS Secretary, Dr. Robert W. Edland, 1836 South Ave., La Crosse, Wis., 54601. Annual Meeting: Hyatt Regency Hotel in the Embarcadero Center, San Francisco, Calif., Oct. 8-12, 1975.

AMERICAN NUCLEAR SOCIETY

Program Chairman, Werner K. Kern, IRD, Space Nuclear Systems, F 309, U. S. Atomic Energy Commission, Washington, D.C. 20545.

AMERICAN INSTITUTE OF ULTRASOUND IN MEDICINE

Secretary, John M. Reid, Ph.D., 556 18th Ave., Seattle, Wash. 98122. Annual Meeting.

Merican Society of Neuroradiology

Secretary, Dr. David O. Davis, Department of Radiology,

901 Twenty-third St., N.W., Washington, D. C. 20037. Annual Meeting.

FOURTEENTH INTERNATIONAL CONGRESS OF RADIOLOGY Rio de Janeiro, Brazil, Oct. 23-29, 1977.

President Elect: Prof. Dr. Nicola C. Caminha; General Secretary: Dr. Durval Couto. Av. Churchill, 97-50 and-LC-39 20,000 Rio de Janeiro, Brazil.

INTERNATIONAL SOCIETY OF RADIOLOGY

Hon. Secretary-Treasurer, Prof. W. A. Fuchs, M.D., Department of Diagnostic Radiology, University Hospital, Inselspital, CH-3010 Bern, Switzerland.

Inselspital, CH-3010 Bern, Switzerland.
TWELFTH INTER-AMERICAN CONGRESS OF RADIOLOGY
President, Dr. Publio Vargas Pazzos, Casilla 5227,
Guayaquil, Ecuador. Meeting in Quito, Ecuador, 1979.
INTER-AMERICAN COLLEGE OF RADIOLOGY
President, Manuel Viamonte, Jr., M.D., Mt. Sinai Medical Center, 4300 Alton Rd., Miami Beach, Fla. 33140.
Secretary, Gaston Morillo, M.D., Jackson Memorial
Hosp., 1700 N.W. 10th Ave., Miami, Fla. 33152.
Counselor for the United States, J. A. del Regato, M.D.,
Univ. of So. Fla. College of Medicine, 13000 No. 30th St.,
Tampa. Fla. 33612. Tampa, Fla. 33612.

THIRD CONGRESS OF THE EUROPEAN ASSOCIATION OF

RADIOLOGY

Secretary-General, P.O. Box 14, 79 Lauriston Place, Edinburgh BHI IDB, Scotland, Meeting: June 22-27, 1975.
SECOND ASIAN AND OCEANIAN CONGRESS OF RADIOLOGY

Secretary, Dr. Buenaventura U. V. Angtuaco, Congress Secretariat Headquarters, 2161 Taft Ave., Manila, Philippines. Meeting: Manila, Philippines, Nov. 10–14, 1975. ALABAMA CHAPTER OF ACR

Secretary-Treasurer, Dr. Lawrence E. Fetterman, 1720
Springhill Ave., Suite 201, Mobile, Ala. 36604. Meets
time and place of Alabama State Medical Association.
ALASKA RADIOLOGICAL SOCIETY, CHAPTER ACR

Secretary-Treasurer, Dr. Maurice J. Coyle, 3200 Provi-

dence Ave., Anchorage, Alaska 99504.
American Osteopathic College of Radiology

Annual Scientific Meeting: Americana Hotel, Bar Harbor, Fla. Program Administrator: Lawrence J. Jordan, D.O., Suite 21, Ponce American Bldg., 4601 Ponce de Leon Blvd., Coral Gables, Fla. 33146. American Thermographic Society

Secretary-Treasurer, John Wallace, Ph.D., Dept. Radiol., Thomas Jefferson Univ. Hosp., Philadelphia, Pa. 19107.

Annual Meeting.

ARIZONA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Robert J. Johnson, 1603 N. Tucson Blvd., Tucson 85716. Two regular meetings a year. Annual meeting at time and place of State Medical Association and interim meeting six months later.

ARK-LA-TEX RADIOLOGICAL SOCIETY
Secretary, Dr. Erich K. Lang, Confederate Memorial
Medical Center, LSU School of Medicine, Shreveport,

La. 71101.

ARKANSAS CHAPTER OF ACR Secretary-Treasurer, Dr. David H. Newbern, 4301 W. Markham, Little Rock, Ark. 72205. Meets twice annually, the Spring Meeting being in conjunction with and at the place of the State Medical Association.

Association of University Radiologists

Secretary-Treasurer, Dr. Mark M. Mishkin. The Graduate Hosp., Univ. of Pennsylvania, Philadelphia, Pa. 23rd Annual Meeting: San Diego, Calif., May 4-6, 1975.

ATLANTA RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Marshall J. Cantanzaro, Dept. of Radiol., Northside Hosp., Atlanta, Ga. 30342. Meets on fourth Thursday evenings during the academic year at a

<sup>\*</sup> Secretaries of societies are requested to send timely information promptly to the Editor.

time announced in early September of each year, at the Academy of Medicine, Atlanta, Ga., at 8:00 P.M. BAVARIAN-AMERICAN RADIOLOGIC SOCIETY

Secretary, Maj. Marco J. DiBiase, M.D., Radiology Service, 130 Station Hosp., APO N. Y. 09102. Next Meeting: Berlin, March 14-16, 1975. BLOCKLEY RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. William H. Green, 616 East 24th

St., Chester, Pa. 19013.
BLUEGRASS RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Eugene Slusher, Lexington Clinic, 1221 S. Broadway, Lexington, Ky. 40504. The Society meets once each month during the school year.

BRONX RADIOLOGICAL SOCIETY, NEW YORK STATE, CHAP-TER ACR

Secretary-Treasurer, Dr. Leon J. Corbin, 1369 Rosendale Ave., Bronx, N. Y. 10472. Meets 4 times a year. BROOKLYN RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Joshua A. Becker, Downstate Medical Clin., 450 Clarkson Ave., Brooklyn, N. Y. 11203. Meets first Thursday of each month, October through June.

BUFFALO RADIOLOGICAL SOCIETY Secretary, Dr. George J. Alker, Jr., E. J. Meyer Mem. Hosp., Buffalo, N. Y. 14215. Meets second Monday evening each month, October to May inclusive, at University Club.

CALIFORNIA RADIATION THERAPY ASSOCIATION Secretary-Treasurer, Dr. Duane J. Gillum, Stanford Medical Center, Stanford, Calif. 94304. Meets semiannually in San Francisco and Los Angeles.

CALIFORNIA RADIOLOGICAL SOCIETY, CALIFORNIA CHAPTER OF ACR

Secretary-Treasurer, Dr. John L. Gwinn, 4650 Sunset Blvd., Los Angeles, Calif. 90027.
CATAWBA VALLEY RADIOLOGICAL SOCIETY

Secretary, Dr. Walter Joe Jacumin, P.O. Box 265, Rutherford College, N. C. 28671. Meets the last Thurs-day of every month, Holiday Inn, Morganton, N. C. at 7:30 P.M.

CENTRAL NEW YORK RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Alfred Brettner, Auburn Mem. Hosp., Auburn, N. Y. 13021. Meets first Monday each month October through May.

CENTRAL OHIO RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Daniel E. Lewis, Grant Hosp., Columbus. Ohio 43215. Meets second Thursday in Columbus, Ohio 43215. Meets second Thursday in October, November, January, and March 15, and May 19 at Fort Hayes Hotel, Columbus, Ohio.

CENTRAL TEXAS RADIOLOGY SOCIETY Secretary-Treasurer, Dr. John M. Stoebner, Scott and White Clinic, Temple, Tex. 76501. Meets the fourth Monday of each month at Ponderosa Hotel, Temple, Tex. at 7:00 P.M.

CHICAGO RADIOLOGICAL SOCIETY, DIVISION OF THE ILLINOIS RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Harold J. Lasky, 55 E. Washington St., Suite 1735, Chicago, Ill. 60602, Meets third Thursday of each month, October to April, except December 18 Biomark Hotel Chicago Ill cember, at the Bismark Hotel, Chicago, Ill.

CLEVELAND RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Charles M. Greenwald, 7007 Powers Blvd., X-Ray Dept., Parma, Ohio 44129. Meetings at 7:00 P.M. on fourth Monday of October, November, January, February, March and fifth Monday of April.

COLORADO RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. John Pettigrew, Denver, Colo. Meets third Friday of each month at Denver Athletic Club from September through May.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY Secretary, Dr. Gerald N. LaPierre, 759 Chestnut St., Springfield, Mass. 01107. Meets in April and October.

DALLAS-FORT WORTH RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Robert R. Burns, 1400 Stemmons Ave., Dallas, Tex. 75208. Meets the 3rd Monday of every month at 6:30 P.M., at the Airport Hotel, Arling-

DELAWARE CHAPTER OF ACR

Secretary, Dr. Seymour R. Kaplan, Kent Gen. Hosp., Dover, Del. 19901.

EAST BAY RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Robert L. Stein, 43 Dormidera Ave., Piedmont, Calif. 94611. Meets first Thursday each month, Oct. through May, at University Club, Oakland,

EAST TENNESSEE RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. George H. Wood, 205 Medical Arts Bldg., Knoxville, Tenn. 37902. Meets in January and September.

FLORIDA RADIOLOGICAL SOCIETY, CHAPTER OF ACR
Secretary. Dr. Paul J. Popovich, 1350 S. Hickory St.,
Melbourne, Fla. 32901. Meets twice annually, in the
spring with the Annual State Society Meeting and in the fall.

FLORIDA WEST COAST RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Herbert Johnson, Davis Blvd., Tampa, Fla. 33606. Meets on 4th Thursday of the months January, March, May, October, and November.

GEORGIA RADIOLOGICAL SOCIETY, CHAPTER OF ACR
Secretary, Dr. E. P. Rasmussen, Piedmont Prof. Bldg., 35
Collier Rd., N.W., Atlanta, Ga. 30309.
GREATER CINCINNATI RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Owen L. Brown, 2421 Auburn Ave., Cincinnati, Ohio 45219. Greater Kansas City Radiological Society

President-Secretary, Dr. Keith W. Gallehugh, Bethany Med. Center, Kansas City, Kans. Meets 5 times a year.

GREATER LOUISVILLE RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. L. D. LeNeave, 315 E. Broad-

way, Louisville, Ky. 40202. Meets monthly. Greater Miami Radiological Society Secretary-Treasurer, Dr. Robert F. Conti, Holy Cross Hosp., Fort Lauderdale, Fla. 33308. Meets monthly, third Wednesday at 8:00 P.M. at various member hospitals, Miami, Fla.

GREATER ST. LOUIS SOCIETY OF RADIOLOGISTS Secretary-Treasurer, Dr. Donald Callahan, Northland

Med. Bldg., Jennings, Mo. 63136.

HAWAII RADIOLOGICAL SOCIETY, CHAPTER OF ACR

Secretary-Treasurer, Dr. Sidney B. W. Wong, Straub
Clinic and Hosp., Honolulu, Hawaii 96813. Meets third Monday of each month at 7:30 P.M.

HEALTH PHYSICS SOCIETY Secretary, Russell F. Cowing, P.O. Box 156, E. Weymouth, Mass. 02189. Annual Meeting.
HOUSTON RADIOLOGICAL SOCIETY

Secretary, Dr. Neill B. Longley, 6436 Fannin, Suite 601, Houston, Tex. 77025. Meets fourth Monday of each month, except June, July, August and December, at 6:00 p.m., at 103 Jesse H. Jones Library Building, Texas Medical Center, Houston, Tex. 77025.

IDAHO STATE RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. John H. Truksa, 1605 Park Ave., Nampa, Id. 83651. Meets in the spring and fall.

ILLINOIS RADIOLOGICAL SOCIETY, INC., CHAPTER OF ACR Secretary Dr. Bohost D. Dollay, Hindels Med. Com.

Secretary, Dr. Robert D. Dooley, Hinsdale Med. Center, Hinsdale, Ill. 60521. Meets in the spring and fall. Indiana Roentgen Society, Inc., Chapter of ACR

Secretary, Dr. John A. Knote, 716 Carrolton Blvd., West Lafayette, Ind. 47906.

IOWA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Dale L. Roberson, 1948 First Ave., NE, Cedar Rapids, Iowa 52402. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific session is held in the autumn.

KANSAS RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Ralph H. Baehr, 310 Medical Arts Bldg., Topeka, Kan. 66604. Meets in spring with State Medical Society and in winter on call.

KENTUCKY CHAPTER OF ACR

Secretary-Treasurer, Dr. Bernard Sams, St. Joseph Infirmary, 735 Eastern Parkway, Louisvlle, Ky. 40217. Meets in April and September.

KINGS COUNTY RADIOLOGICAL SOCIETY

Secretary, Dr. Sidney Hendler, 1880 Ocean Ave., Brooklyn 30, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

KNOXVILLE RADIOLOGICAL SOCIETY Secretary, Dr. Clifford L. Walton, Blount Professional Bldg., Knoxville 20, Tenn. Meetings are held the third Monday of every other month at the University Tennessee Memorial Research Center and Hospital.

LONG ISLAND RADIOLOGICAL SOCIETY Secretary, Dr. Bruce Saxe, 1200 Stewart Ave., Garden City, N. Y. 11533. Meets monthly.

LOS ANGELES RADIOLOGICAL SOCIETY

Secretary, Dr. Isaac Sanders, 1429 Valley View Rd. 13, Glendale, Calif. 91202. Meets second Wednesday of month in September, November, January, April and June at Los Angeles County Medical Association Building, Los Angeles, Calif. Midwinter Radiological Conference. Century Plaza Hotel, Los Angeles, Calif.

LOUISIANA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Roger H. Tutton, 1514 Jeffer-

son Hwy., New Orleans, La. 70121.
LOUISIANA-TEXAS GULF COAST RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Arnold G. Manske, P.O. Box 3008, Port Arthur, Tex. 71670.

MAINE RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Richard W. Taylor, Radiology Department, St. Mary's General Hospital, Lewiston, Maine 04240. Meets in June, September, December and April.

MARYLAND RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. David S. O'Brien, Anne Arundel Hosp., Annapolis, Md. 21401.

MASSACHUSETTS RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Joseph T. Ferrucci, Jr., Massachusetts Gen. Hosp., Boston, Mass. 02114.

MEMPHIS ROENTGEN SOCIETY

Secretary-Treasurer, Dr. Thomas P. Coburn, The University of Tennessee College of Medicine, Department of Radiology, Walter C. Chandler Bldg., 865 Jefferson Ave., Memphis, Tenn. 38163. Meets first Monday Oct. through May at the University Club.

MIAMI VALLEY RADIOLOGICAL SOCIETY

Secretary, Dr. Bert Must, I.B.M. Bldg., Dayton, Ohio. Meets third Thursday of fall, winter and spring months at 7:30 р.м. at Miami Valley Hospital, Dayton, Ohio.

MICHIGAN RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Francis P. Shea, Harper Hospital, 3825 Brush St., Detroit, Mich. 48201. Meets monthly, first Thursday, October through May, at David Whitney House, 1010 Antietam, at 6:30 P.M.

MICHIGAN SOCIETY OF THERAPEUTIC RADIOLOGISTS Secretary-Treasurer, Dr. Delmar Mahrt, William Beaumont Hosp., Detroit, Mich. 48072. Meets bi-monthly during the academic year.

MID-HUDSON RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. William D. Stiehm, 37 Flower Hill Rd., Poughkeepsie, N. Y. 12603. Meets 7:00 P.M., first Wednesday of each month, September to May.

MILWAUKEE ROENTGEN RAY SOCIETY Secretary-Treasurer, Dr. Thomas C. Lipscomb, 1004 North Tenth St., Milwaukee, Wis. 53233. Meets monthly on fourth Monday, October through May, at University

MINNESOTA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Marvin E. Goldberg, Box 292, Mayo Memorial Health Sciences Center, Minneapolis, Minn. 55455.

MISSISSIPPI STATE RADIOLOGICAL SOCIETY, CHAPTER OF

Secretary-Treasurer, Dr. Edward L. Gieger, 969 Lakeland Dr., Jackson, Miss. 39216. Meets third Thursday, excluding summer months, at the Primos Northgate Rest., Jackson at 6:30 P.M.

MISSOURI RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Ronald G. Evens, Mallinckrodt Institute of Radiology, 510 S. Kingshighway, St. Louis,

MONTANA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. C. H. Agnew, Room 102, Doctors Bldg., Billings, Mont. 59101.

NEBRASKA CHAPTER OF ACR

Secretary-Treasurer, Dr. Robert Bodmer, Suite 622 Doctors Bdg., Omaha, Neb. 68131. Meets the third Wednesday of the month, Oct. through March, at the Clarkson Hosp., Omaha, Neb. and the fourth Friday of April at the Lincoln Country Club, Lincoln, Neb.

NEVADA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Charles F. Veverka, Carson Tahoe Hosp., Carson City, Nev. 89701.

N.E. SOCIETY FOR RADIATION ONCOLOGY Secretary, Dr. C. C. Wang, Mass. Gen. Hosp., Boston,

Mass. 02114.

New England Roentgen Ray Society
Secretary, Dr. Melvin E. Clouse, 185 Pilgrim Rd.,
Boston, Mass. 02115. Meets the third Friday of each
month, October through April, excluding December, at
The Longwood Towers, 20 Chapel Street, Brookline,
Mass. at 3:00 p.m. Annual Meeting: May 16, 1975.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY, CHAPTER OF

ACR

Secretary-Treasurer, Dr. Edward P. Kane, Claremont Gen. Hosp., Claremont, N. H. 03743. Meets four to six

times yearly.

New Mexico Society of Radiologists, Chapter of ACR Secretary, Dr. W. M. Jordan, 1100 Central Ave. S.E., Albuquerque, N. M. 87106. Four meetings annually, three held in Albuquerque, N. M., and one held at time and place of New Mexico State Medical Society annual meeting.

NEW ORLEANS RADIOLOGICAL SOCIETY, INC. Secretary-Treasurer, Dr. Jimmy L. Mains, P.O. Box 446, Gretna, La. 70053. Meets bimonthly at local restaurants

selected by the President. Spring Conference.

NEW YORK ROENTGEN SOCIETY Secretary-Treasurer, Dr. Thomas C. Beneventano, 110 East 210th St., Bronx, N. Y. 10467. Meets monthly on the 3rd Monday at the New York Academy of Medicine at 4:30 P.M. Annual Spring Conference, Waldorf-Astoria Hotel, New York, N. Y., April 24–26, 1975. A.M.A. Cat. I credit. Further information may be obtained from Dr. Albert A. Dunn, Roosevelt Hosp., New York, N. Y.

NEW YORK STATE CHAPTER OF ACR Secretary-Treasurer, Dr. Albert F. Keegan, 6 Secor Dr., Port Wash., N. Y. 11050.

North American Society of Cardiac Radiology Secretary-Treasurer, Dr. Erik Carlson, Univ. Calif., San Francisco, Calif. 94143. North Carolina Chapter of ACR

Secretary-Treasurer, Dr. Ernest B. Spangler, Wesley Long Hosp., Greensboro, N. C. 27402. Meets twice a year. The Spring Meeting is held at the time of the meeting of the North Carolina Medical Society. The Fall Meeting is held in November at the Mid Pines Club, Southern Pines, N.C.

NORTH DAKOTA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Pablo Ramos, Box 1618, Bismarck, N. D. 58501. Meets at time of State Medical Association meeting. Other meetings arranged on call of the President.

NORTH FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. David F. Bew, University Hospital of

Jacksonville, 655 W. Eighth Street, P.O. Box 2751, Jacksonville, Fla. 32203. Meets quarterly in March, June, September and December.

Northeastern Oklahoma Radiological Society
Secretary-Treasurer, Dr. Theodore J. Brickner, Jr., 5919

S. Gary Place, Tulsa, Okla. 74110. Northeastern New York Radiological Society Secretary, Dr. Donald R. Morton, Dept. of Radiology, St. Clare's Hosp., Schenectady, N. Y. 12304. Meets in Albany area on third Wednesday of October, November, March, April, and May.
Northern California Radiation Therapy Association

Secretary-Treasurer, Dr. John D. Earle, Stanford Medical Center, Stanford, Calif. 94304. Meets quarterly. Northern California Radiological Society

Secretary, Dr. Mark D. Reiss, 5301 F Street, Sacramento, Calif. 95819. Meets on the fourth Monday of Sept., Nov., Jan., March and May at the Mansion Inn, Sacramento,

NORTHWESTERN NEW YORK RADIOLOGICAL SOCIETY

Secretary, Dr. Barbara E. Chick, Glens Falls Hospital, Glens Falls, N. Y. 12801.

NORTHWESTERN OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Richard W. Siders, 421 Michigan, Toledo, Ohio 43624. Meets 3rd Wednesday from September to May.

OHIO STATE RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Tearle L. Meyer, 175 S. Merkle Rd.,

Columbus, Ohio 43215.

OKLAHOMA STATE RADIOLOGICAL SOCIETY, CHAPTER OF ACR

Secretary, Dr. George H. Ladd, 4616 Denison, Muskogee, Okla. 74401. Meets in January, May and October. Orange County Radiological Society

Orange, Calif. 92667. Meets on fourth Tuesday of the month, excluding June, July, August, and December, at Orange County Medical Association Bldg., Orange,

OREGON STATE RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Robert E. Craven, P.O. Box 12542, Portland, Ore. 97212. Meets on second Wednesday of month, October through April, at the University Club, Portland, Ore.

ORLEANS PARISH RADIOLOGICAL SOCIETY Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans, La. 70113. Meets second Tuesday of each

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Betty J. Wood, Dept. of Radiol., Vancouver General Hosp., Vancouver 9, B. C., Canada.

Annual Meeting. Pennsylvania Radiological Society, Chapter of ACR Secretary, Dr. Robert B. Funch, Germantown Hosp., Philadelphia, Pa. 19144.

Philadelphia Roentgen Ray Society
Secretary, Dr. Marvin E. Haskin, 230 N. Broad St., Philadelphia, Pa. 19102. Meets first Thursday of each

month at 5 P.M., from October to May in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY Secretary, Dr. Klaus M. Bron, Presbyterian-Univ. Hosp., Pittsburgh 15213. Meets second Wednesday of month, September through May, at the Pittsburgh Athletic As-

RADIATION RESEARCH SOCIETY Executive Secretary, Richard J. Burk, Jr., 4211 39th St., N.W., Washington, D. C. 20016. Annual Meeting. RADIOLOGICAL SOCIETY OF CONNECTICUT, INC., CHAPTER

or ACR Secretary-Treasurer, Dr. Mehdi S. Eslami, 1389 W. Main St., Waterbury, Conn. 06708.

RADIOLOGICAL SOCIETY OF GREATER CINCINNATI Secretary-Treasurer, Dr. Alvin Nathan, c/o Academy of Medicine, 320 Broadway, Cincinnati, Ohio 45202. Meets first Monday of each month at Cincinnati Academy of Medicine.

RADIOLOGICAL SOCIETY OF NEW JERSEY, CHAPTER OF ACR Secretary, Dr. Fred M. Palace, 11 Dale Dr., Morristown, N.J. 07960. Monthly meetings in East Orange and Trenton, N.J. Semi-Annual Meeting in Nov.
Radiological Society of Rhode Island, Chapter of ACR

Secretary-Treasurer, Dr. Daniel J. Alves, Rhode Island Hosp., Providence, R. I. 02902.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA Secretary-Treasurer, Dr. A. Franklin Turner, LAC-USC Medical Center, Room 3418, 1200 North State St., Los Angeles, Calif. 90033. Meets three times a year, usually October, February and May.

RADIOLOGICAL SOCIETY OF THE STATE OF NEW YORK Secretary-Treasurer, Dr. John W. Colgan, 273 Hollywood Ave., Rochester, N. Y. 14618.
REDWOOD EMPIRE RADIOLOGICAL SOCIETY

Secretary, Dr. Charles E. Carter, 121 Sotoyome St., Santa Rosa, Calif. 95405. Meets second Monday every other month.

RICHMOND COUNTY RADIOLOGICAL SOCIETY
Secretary, Dr. Donald P. King, 218 Gun Club Rd., Richmond, Va. 23221. Meets first Thursday of each month at various hospitals.

Secretary-Treasurer, Dr. Robert J. Bruneau, Rochester General Hosp., Rochester, N. Y. 14621. Quarterly meetings on the call of the President, at the Rochester Academy of Medicine.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Lorenz R. Wurtzebach, 4200 E. Ninth Ave., Denver, Colo. 80220. Annual meeting: Brown Palace Hotel, Denver, Colo., Aug. 21–23, 1975. SAN ANTONIO-CIVILIAN MILITARY RADIOLOGICAL SOCIETY Secretary, Dr. James R. Stewart, Oak Hills Medical Ctr.,

San Antonio, Tex. 78209. Meets third Wednesday of each month at Fort Sam Houston Officers Club at

SAN DIEGO RADIOLOGICAL SOCIETY President, Dr. Stanley G. Seat, 476 Prospect St., La Jolla, Calif. 92037. Meets the first Wednesday of each month at the University Club.

SAN FRANCISCO RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Charles A. Gooding, Univ. of Calif. Med. Ctr., San Francisco, Calif. 94122.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION Secretary, Dr. William H. Graham, 630 East Santa Clara St., San Jose, Calif.

Section on Radiology, Medical Society of the District of Columbia Secretary-Treasurer, Dr. Albert M. Zelna, 21 Masters St., Potomac, Md. 20854. Meets at Medical Society Library, third Wednesday of January, March, May and October at 8:00 P.M.

Section of Radiology, National Medical Association Secretary, Dr. Ruby Brooks, Dept. Radiol., Veterans Adm. Hosp., P.O. Box 511, Tuskogee, Ala. 36083. Annual Meeting.

Section on Radiology, Southern Medical Association Secretary, Dr. Mario A. Calonje, 1514 Jefferson Highway, New Orleans, La. 70121. Annual Meeting.

Section on Radiology, Texas Medical Association Secretary, Dr. George F. Crawford, St. Elizabeth Hospital, Beaumont, Tex. Meets annually with the Texas Medical Association.

SHREVEPORT RADIOLOGICAL CLUB Secretary, Dr. W. R. Harwell, 608 Travis St., Shreveport, La. Meets monthly on third Wednesday at 7:30 P.M., September to May inclusive.

SOCIETY FOR PEDIATRIC RADIOLOGY Secretary-Treasurer, Dr. John P. Dorst, 601 N. Broadway, Baltimore, Md. 21205. Annual meeting: Marriott Hotel, Atlanta, Ga., Sept. 28-29, 1975.

SOCIETY OF GASTRO-INTESTINAL RADIOLOGISTS

Secretary-Treasurer, Dr. John R. Amberg, University Hospital, 225 W. Dickinson St., San Diego, Calif. 92103.

SOCIETY OF NUCLEAR MEDICINE

Secretary, Dr. E. James Potchen, Edward Mallinckrodt Institute of Radiology, 660 S. Éuclid Ave., St. Louis, Mo. 63110. *Administrative Officer*, Mrs. Margaret Glos, 211 E. 43rd St., New York, N. Y. 10017. Annual Meeting.

South Bay Radiological Society

Secretary, Dr. Robert Mindalzun, Valley Radiologists,
Inc., 100 O'Connor Dr., San Jose, Calif. 95128. Meets
the 2nd Monday of each month at the Santa Clara County Medical Society Bldg., 700 Empey Way, San Jose, Calif.

SOUTH CAROLINA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. George W. Brunson, 1406 Gregg St., Columbia, S. C. Annual meeting (primarily business) in conjunction with the South Carolina Medical Association meeting in May. Annual fall scientific meeting at

time and place designated by the president.
South Coast Radiological Society Chapter of ACR Secretary-Treasurer, Dr. Richard T. Love, Santa Barbara Med. Clin, 215 Pesetas Lane, Santa Barbara, Calif. 93110. Meets fourth Tuesday of alternate months, Sept., Nov., Jan., March and May.

SOUTH DAKOTA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. M. F. Petereit, 2416 S. Phillips, Sioux Falls, S. D. 57105. Meets in spring with State Medical Society and in fall.

SOUTHERN CALIFORNIA RADIATION THERAPY ASSOCIATION Secretary-Treasurer, Dr. Duane J. Gillum, 250 W. Pueblo St., Santa Barbara, Calif. 93105. Meets quarterly.

SOUTHERN RADIOLOGICAL CONFERENCE
Secretary-Treasurer, Dr. J. W. Maxwell, P.O. Box 2144
Mobile Ala. 36601. Annual Meeting: Grand Hotel, Point
Clear, Ala., Jan. 31-Feb. 2, 1976.
TENNESSEE RADIOLOGICAL SOCIETY, CHAPTER OF ACR
Secretary-Treasurer, Dr. Jerry W. Grise, Methodist
Hosp., 1265 Union Ave., Memphis, Tenn. 38104. Meets
annually at the time and place of the Tennessee State
Medical Association meeting.

Medical Association meeting.

Texas State Radiological Society, Chapter of ACR Secretary, Dr. Francis E. O'Neill, 1128 Nix Prof. Bdg., San Antonio, Tex. 78205.

The Fleischner Society

Secretary, Dr. E. Robert Heitzman, State University of New York Upstate Medical Center, Syracuse, N. Y. 13210. Annual Meeting: St. Francis Hotel, San Francisco, Calif., May 28-31, 1975.

TRI-STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Alfred Lessure, Welborne Hosp., Evansville, Ind. 47714. Meets bimonthly on the third Wednesday at Arco Hospitals.

UPPER PENINSULA RADIOLOGICAL SOCIETY Secretary, Dr. A. Gonty, Menominee, Mich. Meets quar-

UTAH STATE RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Patrick D. Lester, Dept. Radiol., University of Utah Medical Center, Salt Lake City, Utah 84112. Meets quarterly at Holy Cross Hospital.

Vermont Radiological Society, Chapter of ACR Secretary, Dr. J. Lorimer Holm, R.R. #3, Barre, Vt. 05641.

VIRGINIA CHAPTER OF ACR

Secretary-Treasurer, Dr. Charles P. Winkler, 3500 Kensington Ave., Suite 2-A, Richmond, Va. 23221.

WASHINGTON, D. C., CHAPTER OF ACR

Secretary-Treasurer, Dr. Robert M. Allen, 9312 Convento Terr., Fairfax, Va. 22030.

WASHINGTON STATE RADIOLOGICAL SOCIETY, CHAPTER OF

Secretary-Treasurer, Dr. Donald J. Hesch, 3216 N.E. 45th Place, Seattle, Wash. 98105.

WEST VIRGINIA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Andrew W. Goodwin, II, 200 Med. Arts Bldg., Charleston, W. Va. 25301. Meets concurrently with annual meeting of West Virginia State Medical Society, other meetings arranged by program committee.

WESTCHESTER COUNTY RADIOLOGICAL SOCIETY Secretary, Dr. James O. Richardson, Jr., 280 Mamaronek Ave., White Plains, N. Y. 10605. Meets on second Tuesday of October, December, February and May.

WISCONSIN RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. June Unger, Wood VA Hosp., Wood, Wis. 53193. Meets twice a year, May and Sep-

Wisconsin Society of Therapeutic Radiologists Secretary, Dr. Alvin Greenberg, Radiother. Ctr., Univ. Hospitals, Madison, Wis. 53706. Meets quarterly.

WYOMING RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Ross J. Collie, Box 96, Lander, Wyo. 82520. Meets in fall with State Medical Society and in spring on call of President.

#### MEXICO, PUERTO RICO AND CENTRAL AMERICA

Asociación Costarricense de Radiología Secretary, Dr. Rafael Umaña-Umaña, Apartado 8-5340, San José, Costa Rica.

Asociacón de Radiólogos de Centro America y PANAMÁ. Comprising: Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panamá

Secretary-General, Dr. Francisco Miranbell Solis, Apartado 3352, San José, Costa Rica, Central America. Meets annually in a rotating manner in the six countries.

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA Secretary, Dr. R. B. Díaz Bonnet, Suite 504, Professional Bldg., Santurce, Puerto Rico.

SOCIEDAD DE RADIOLOGÍA DE SALVADOR Secretary, Dr. Carlos Meijia, 5a Av. Nte. No. 434, San Salvador, Rep. El Salvador.

SOCIEDAD DE RADIOLOGÍA DE GUATEMALA Secretary, Dr. Carlos E. Escobar, 92, Calle Ao-05, Zona I.

SOCIEDAD MEXICANA DE RADIOLOGÍA, A.C. Coahuila No. 35, México 7, D.F., México. Secretary-General, Dr. Jorge Cano Coquí. Meets first Monday of each month.

Sociedad Radiológica Panameña

Secretary, Dr. L. Arrieta Sánchez, Apartado No. 6323, Panamá, R. de P. Meets monthly in a department of radiology of a local hospital chosen at preceding meeting. SOCIEDAD RADIOLÓGICA DE PUERTO RICO

Secretary, Dr. Heriberto Pagán Sáez, Box 9387, Santurce, Puerto Rico. Meets second Thursday of each month at 8:00 P.M. at the Puerto Rico Medical Association Bldg. in San Juan.

#### BRITISH COMMONWEALTH OF NATIONS

Association of Radiologists of the Province of QUEBEC 121 Boul. Taschereau, Greenfield Park, P. Q., Canada.

Meets four times a year. BRITISH INSTITUTE OF RADIOLOGY

Honorary Secretaries, D. H. Traspnell, M. Cohen, 32 Welbeck St., London, W1M/7PG, England.

CANADIAN ASSOCIATION OF PHYSICISTS, DIVISION OF MED-ICAL AND BIOLOGICAL PHYSICS Honorary Secretary-Treasurer, Dr. R. G. Baker, Ontario Cancer Foundation, Ottawa Civic Clinic, 1053 Carling Ave., Ottawa 3, Ont., Canada.

CANADIAN ASSOCIATION OF RADIOLOGISTS Honorary Secretary, Dr. Ross O. Hill, Suite 806, 1440 St. Catherine St. West, Montreal 107, Que., Canada. Thirtyeighth Annual Meeting: Toronto, Ont., May 11-16, 1975.

EDMONTON AND DISTRICT RADIOLOGICAL SOCIETY

Secretary, Dr. L. A. Koller, Suite 360, Professional Bldg., 10830 Jasper Ave., Edmonton 15, Alberta, Canada. Meets third Thursday of each month October to May, except December, at various Edmonton Hospitals.

FACULTY OF RADIOLOGISTS

Honorary Secretary, P. D. Thomson, 28 Portland Pl., London, WIN 4DE. MONTREAL RADIOLOGICAL STUDY CLUB

Secretary, Dr. W. Paul Butt, Montreal General Hospital, Montreal, Que., Canada. Meets first Tuesday evening, October to April.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDI-CINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 8:15 P.M. at the Royal Society of Medicine, I Wimpole St., London, W. I

M8AE, 1 England.

Société Canadienne-Française de Radiologie Secretary-General, Dr. Hubert Sasseville, Verdun Hospital, Montréal, P. Q., Canada. Meets every third Tuesday from October to April.

THE HOSPITAL PHYSICISTS' ASSOCIATION

Honorary Secretary, J. B. Massey, B.Sc., Christie Hosp. and Holt Radium Institute, Physics Department, Withington, Manchester M20 9BX, England.

TORONTO RADIOLOGICAL SOCIETY

Secretary, Dr. George Wortzman, Toronto General Hosp., Toronto 12, Ont., Canada. Meets second Monday of each month, September through May.

THE ROYAL AUSTRALASIAN COLLEGE OF RADIOLOGISTS

Honorary Secretary, Dr. T. P. Loneragan, 45 Macquarie
St., Sydney, N.S.W. 2000, Australia.

#### South America

Colégio Brasileiro de Radiologia

Secretary-General, Dr. José Marcos Pires de Oliveira, Caixa Postal 5984, São Paulo, Brazil.

FEDERACIÓN ARGENTINA DE SOCIEDADES DE RADIOLOGÍA Branches of the Federation are: Sociedad de Radiólogos de la Provincia de Córdoba; Sociedad Argentina de Radiología; Asociación Argentina de Radiología; Sociedad de Radiología, Radioterapéutica y Medicina Nuclear de Rosario; Sociedad de Radiología y Medicina Nuclear del Centro y Sudeste de la Provincia de Buenos Aires (Mar del Plata); Sociedad Salteña de Radiología y Medicina Nuclear; Sociedad de Radiología de Tucumán; Sociedad de Radiologia del Nordeste Argentino; Sociedad de Radiología de La Plata; and Sociedad de Radiología de San Iuan.

Secretary-General-Treasurer, Dr. Roberto Habichayn, Av.

Colón 637, Córdoba, Argentina.

Congress will be organized by Sociedad de Radiología, Radioterapéutica y Medicina Nuclear de Rosario in 1975.

Sociedad Argentina de Radiología

Secretary-General, Dr. Tomás J. Gutiérrez F, Santa Fé 1171, Buenos Aires, Argentina. Meets first Wednesday evening, April through December.

Sociedad Boliviana de Radiología

Secretary, Dr. Javier Prada Méndez, Casilla 1182, La Paz, Bolivia. Meets monthly. General assembly once every two years.

Sociedade Brasileira de Radiologia

Secretary, Dr. Armando Rocha Amoédo, Caixa Postal 1532, Rio de Janeiro, Brazil. General Assembly meets every two years in December.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA

Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Chilena de Radiología

Secretary, Dr. Manuel Neira, Casilla 13426, Santiago, Chile. Meets first Friday of each month at Av. Santa María 1810 at 7:00 P.M.

Sociedad Colombiana de Radiología

Secretary-General, Dr. Gustavo Sánchez Sánchez, Bogotá, Colombia. Meets last Thursday of each month.

SOCIEDAD ECUATORIANA DE RADIOLOGÍA Secretary, Dr. Luis Blum, Casilla 3712, Guayaquil, Ecua-

Sociedad Paraguaya de Radiología
Secretary, Dr. Hugo Volpe Rios, 15 de Agosto 322,
Asunción, Paraguay.

Sociedad Peruana de Radiología

Secretary-General, Dra. Ladis Delpino, Av. General Santa Cruz No. 315, Miraflores, Lima, Perú, Casilla Correo, 2306, Lima, Perú. Meets monthly except during January, February, and March.

SOCIEDAD DE RADIOLOGÍA DEL ATLANTICO

Secretary, Dr. Raul Fernandez, Calle 40 #41-110, Baran-quilla, Colombia. Society meets monthly at the Instituto

de Radiología.

Sociedad de Radiología del Nordeste Argentino Secretary-General, Dr. Francisco J. Velar, Catamarca 561, Corrientes, Argentina. Sociedad de Radiología de La Plata

Secretary, Dr. Hiram D. Haurigot, Calle 50 No. 374, La

Plata, Argentina.

Sociedad de Radiología, Cancerología y Física Médica del Uruguay Secretary-General, Dr. Manuel Gonzáles Maseda, Av.

Agraciada 1464, piso 13, Montevideo, Uruguay. Sociedade de Radiología de Pernambuco

Secretary, Dr. Manoel Medeiros Instituto de Radiologia da Faculdade de Medicina da Universidade do Recife,

Caixa Postal 505, Pernambuco, Brazil.
Sociedad de Roentgenología y Medicina Nuclear de la Provincia de Córdoba

Secretary-General, Dr. Lucas C. Di Rienzo, Ave. Grl. Paz. 151, Córdoba, Argentina.

Sociedad de Radiología, Radioterapéutica y Medicina Nuclear de Rosario Secretary-General, Dr. Federico Frágola, Santa Fe 1798,

Rosario, Argentina.

Sociedad Salteña de Radiología y Medicina Nuclear Treasurer, Dr. Julio Luis Baldi, Av. Sarmiento 536, Salta, Argentina

SOCIEDAD VENEZOLANA DE RADIOLOGÍA Y MEDICINA NU-CLEAR

Secretary-General, Dr. Salvador Itriago Borgas, Apartado Postal 9213, Candelaria, Caracas, Venezuela. Meets monthly, third Friday at Colegio Médico del Distrito Federal, Caracas.

#### CONTINENTAL EUROPE

ÖSTERREICHISCHE RÖNTGEN-GESELLSCHAFT

Secretary, Dr. Ernst Kotcher, Wiener Allgemeine Poliklinik Mariannengasse 10, A-1090 Wien, Austria. Meets second Tuesday of each month in Allgemeine Poliklinik. Société ROYALE BELGE DE RADIOLOGIE

General Secretary, Dr. Joseph Baeyens, Alost, Belgium. Meets in February, March, May, June, September, October, November and December.

Société Européenne de Radiologie Pédiatrique Secretary, Dr. J. Corbaton, Clinica Infantil "La Paz," Av. Generalissimo, 117 Madrid 34, Spain. Annual Meet-

ing: Madrid, Apr. 24-26, 1975.

Permanent Secretary, Clément Fauré, Hôpital des Enfants
Malades, 149, rue de Sèvres, 75 730, Paris Cadet 15, France.
Société Française de Radiologie Médicale, Médecine

NUCLÉAIRE ET ÉLECTROLOGIE, and its branches: Société du Sud-Ouest, du Littoral méditerranéen, du CENTRE ET LYONNAIS, DU NORD, DE L'OUEST, DE L'EST, DU MASSIF CENTRAL, D'OUTRE-MER ET D'ÉTRANGER. Parent Society meets third Monday of each month, except during July, August and September, rue de Seine 12, Paris, France.

Secretary-General, Dr. Ch. Proux, 9 rue Daru, Paris 75008, France.

Société Française de Neuroradiologie

Secretary-General, Professeur agr. R. Djindjian 16, rue de l'Université 75, Paris 7°, France. Annual meeting.

ČESKOSLOVENSKÁ RADIOLOGICKÁ SPOLEČNOST Secretary, Associate Professor Jaromír Kolář, M.D., Sc.D., Radiological Clinic, Praha 2, U nemocnice 2, Czechoslovakia. Meets monthly except during July, August and September. Annual general meeting.

Deutsche Röntgengesellschaft
President, Professor Dr. med. Walter Frommhold, Director of Medizinisches Strahleninstitut der Universität Tübingen, Röntgenweg 11, 7400 Tübingen, Germany.

FACULTY OF RADIOLOGISTS OF THE ROYAL COLLEGE OF SURGEONS IN IRELAND

Honor. Secretary, Max. J. Ryan, St. Stephen's Green, Dublin 2. Annual Meeting, Oct. 25 and 26, 1974. Società Italiana di Radiologia Medica e Medicina

NUCLEARE

Administrative Secretary, Prof. E. Conte, Ospedale Mauriziano, 10128 Torino, Italy. Meets annually. SOCIETAS RADIOLOGICA DANICA

Secretary, Dr. Bent Langenfeldt, Tretommervej 20a, DK. 8240 Risskov, Denmark.
NEDERLANDSE VERENIGING VOOR RADIOLOGIE

Secretary, Dr. J. D. Mulder, Dept. of Rad., Akademisch Ziekenhuis, Leiden, Netherlands.

NORSK FORENING FOR MEDICINSK RADIOLOGI General Secretary, Gunnar Stake, Rikshospitalet, Oslo, Norway.

SCANDINAVIAN RADIOLOGICAL SOCIETY Secretary-General, Professor C. F. Unnérus, M.D., Hagalung-Tapiola, Havsvindsvägn 5 C., Finland. Annual Meeting.

SOCIEDAD ESPAÑOLA DE RADIOLOGÍA Y ELECTROLOGÍA MÉDICAS Y DE MEDICINA NUCLEAR Secretary-General, Dr. Pilar Gallar Barberá, Villanueva,

11, Madrid 1, España. Meets every other Saturday evening of each month, Oct. to June, inclusive, in Madrid. Sociedade Portuguesa de Radiologia e Medicina

NUCLEAR Secretary-General, Dr. Luís Aires de Sousa, Av. Elias Garcia, 123- 1, Esg.-Lisboa i-Portugal.

Svensk Förening för Medicinsk Radiologi Secretary, Dr. Hanz Ringertz, Röntgendiagnostika Avdelningen, Karolinska Sjukhuset 104 01 Stockholm 60, Sweden.

Schweizerische Vereinigung für Radiologie, Nu-KLEARMEDIZIN UND STRAHLENBIOLOGIE (ASSOCIATION Suisse de Radiologie, Médecine Nucléaire et de RADIOBIOLOGIE) Secretary, Dr. med. Gustav Schoch, Bethesdaspital, Gellerstrasse 144, 4000 Basel, Switzerland.

BENGAL RADIOLOGICAL ASSOCIATION Honorary Secretary, Dr. B. Chatterji, 262 Rash Behari Ave., Calcutta 700019, India. Meets 1st Fri. and 3rd Wed. of every month.
Indian Radiological Association

Honor. Gen. Secretary, Dr. S. P. Aggarwal, 10-B Kasturba Ghandi Marg, New Delhi iioooi. 28th Indian Congress of Radiology will be held in Hyderabad in 1975.

INDONESIAN RADIOLOGICAL SOCIETY Secretary, Dr. Gani Iljas Sasmitaatmadja, Radiology Dep., Faculty of Medicine, University of Indonesia, Salemba 6, Jakarta, Indonesia. Iranian Radiological Society

Secretary, Dr. Majid Rooholamini, P.O. Box No. 14-1151, Teheran, Iran. The Society meets on the second Saturday of each month. 5th Iranian Congress of Radiology, Apr. 12-17, 1975.

ISRAEL RADIOLOGICAL SOCIETY Secretary, Dr. M. A. Lerner, Hesharon Hosp., Petah-Tigva, Israel.

PHILIPPINE COLLEGE OF RADIOLOGY PHILIPPINE COLLEGE OF RADIOLOGY

Secretary-Treasurer, Dr. Eduardo V. Nievera, Box 1284
Commercial Center, Makati, Rizal D-708, Philippines.
Meets every second Thursday of the month.

RADIOLOGICAL SOCIETY OF THAILAND

Secretary, Prof. Rojana Suvansuthi, M.D., Ph.D.,
Depart. of Rad., Sirizaj Hospital, Faculty of Medicine,

Mahidol University, Bangkok 7, Thailand.

#### AFRICA

Association of Radiologists of West Africa

Honorary Secretary, C. A. Beetlestone, M.B., B.S.,
D.M.R.D., Dept. Radiol., University College Hosp.,
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# ABSTRACTS OF RADIOLOGIC LITERATURE

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#### ROENTGEN DIAGNOSIS

#### NECK AND CHEST

DOPPMAN, JOHN L., GEELHOED, GLENN W., and DE VITA, VINCENT T. Atypical radiographic features in pneumocystis carinii pneumonia. *Radiology*, Jan., 1975, 114, 39-44. (Address: John L. Doppman, Department of Diagnostic Radiology, Building 10, Room 6S211, National Institutes of Health, Bethesda, Md. 20014.)

The authors reviewed 30 cases of proved pneumocystis carinii pneumonia. The group of patients all had a lymphoreticular neoplasm (leukemia or lymphoma) or a primary immunodeficiency disease. All of the patients had received some type of combined chemotherapy, steroid, or wide spectrum antibiotic therapy. The purpose of the review was to attempt to answer 2 questions asked by clinicians.

- 1. Is the chest roentgenogram in pneumocystis carinii pneumonia sufficiently typical to warrant institution of therapy without tissue diagnosis?
- 2. Are certain atypical radiographic features sufficiently rare in pneumocystis to exclude this diagnosis without a biopsy?

The typical radiographic features were discussed. Reference to several recent articles was made in the discussion of the typical or classic radiographic findings.

The atypical findings encountered in the series included: apical involvement; unilateral predominance of the infiltrate; pseudo-nodularity; central excavation suggesting cavitation; pleural fluid; hilar prominence; and rapid massive progression. Autopsy findings in the 18 fatal cases revealed lymphadenopathy in 6 patients. However, in these 6 patients there was lymph node enlargement secondary to the underlying lymphoproliferative disorder.

The answers to the questions raised by the authors are as follows. It was their impression that the typical or classic radiographic findings in the appropriate clinical setting justify the diagnosis of pneumocystis carinii pneumonia. Therapy can be initiated on this presumptive diagnostic basis in the absence of tissue or histologic diagnosis. The second question was more difficult to answer. The authors conclude that the incidence of atypical findings (17 of 30 patients in their series) is sufficiently high, so that the diagnosis of pneumocystis cannot be excluded by the occurrence of atypical findings.

In summary they say that in an immunosuppressed patient, biopsy may be indicated in the absence of a classic radiographic presentation.—J. P. Eberts,

OSBORN, ANNE G., and SILVERMAN, JAMES F. Unusual venous drainage patterns in the

scimitar syndrome. Radiology, Dec., 1974, 113, 601-603. (Address: James F. Silverman, M.D., Department of Radiology, Stanford University Medical Center, Stanford, Calif. 94305.)

The classical scimitar syndrome and scimitar sign are discussed.

Two cases of unusual types of venous drainage are reported. One case represented side-by-side or "double scimitar" venous drainage to the inferior vena cava. The other demonstrated simultaneous venous return from the right lung to both the inferior vena cava and left atrium via a scimitar shaped vein.

In both cases, the unusual veins could be seen on plain chest roentgenograms in addition to the classical scimitar vein. Both cases were confirmed by pulmonary angiography.

The scimitar variant syndrome should be considered if other abnormal veins are seen in addition to the typical scimitar vein.—A. K. Teaford, M.D.

BIRAN, S., HOCHMAN, A., and SCHWARTZ, A. Diagnosis and therapy in cystic disease of the breast: combined aspiration and pneumocystography. *Radiol. clin. et biol.*, 1974, 43, 571-579. (Address: S. Biran, M.D., Hadassah University Hospital, P. O. Box 499, 91000 Jerusalem, Israel.)

Benign cysts of the breasts may be considered a physiologic phenomenon, involving 20–54 per cent of the female population. Only I per cent of carcinomas of the breast are intracystic. To avoid repetitive biopsies which result in scarring, mutilation, and emotional trauma, the authors recommend aspiration and pneumocystography for masses which are diagnosed as cysts by palpation, transillumination, and mammography. Fifty-seven patients have been followed for 5 years. Twelve patients had single aspirations without recurrence. Thirty-four patients required multiple aspirations. In 72 per cent, new cysts developed within I year following diagnosis of the first cyst. No carcinoma was overlooked.

Eleven patients had surgical biopsies. Four had benign cysts. The biopsies were performed in 2 because of rapid refilling of the cyst, in 1 because the aspirated fluid was bloody, and in 1 because the cytologic examination of the fluid was equivocal. Seven patients had dry taps: 4 had fibromas, and 3 had carcinomas.

The technique is safe. Fluid is aspirated through a No. 20 gauge needle, which is left in place. The same quantity of air is injected with a second syringe, followed by mammography in 2 planes. The fluid is examined for cytology. Fluid was yellowish and cloudy in 58 per cent, yellow and clear in 14 per cent, and cloudy brown in 28 per cent.

Unilocular thin walled cysts will collapse as the air is absorbed. Multiloculated and thick wall cysts will

not collapse, and can be expected to recur. A definite diagnosis of benign mammary cyst can be made when the pneumocystogram outlines a smooth inner membrane without evidence of intracystic growth.—

Adele R. Altman, M.D.

#### ABDOMEN

HASWELL, DONALD M., BERNE, ALFRED S., and Schneider, Bernard. Plain film recognition of the ligamentum teres hepatis. *Radiology*, Feb., 1975, 114, 263-267. (Address: Alfred S. Berne, M.D., Department of Diagnostic Radiology, Crouse-Irving Memorial Hospital, 736 Irving Avenue, Syracuse, N. Y. 13210.)

In 30 per cent of patients, a vertical radiolucent linear shadow in the right upper quadrant of the abdomen can be identified. The appearance suggests the presence of a right upper quadrant suprarenal mass

Through high dose nephrotomography, cadaver dissection and during abdominal laparotomy, it was shown that this radiolucent line is related to fat surrounding the ligamentum teres hepatis. The anatomy is reviewed.

This normal anatomic structure should not be misinterpreted as the border of a pathologic right upper quadrant mass.—J. A. Chapman, M.D.

PHILLIPS, JOSEPH F., COCKRILL, HOWARD, JORGE, EDUARDO, and STEINER, ROBERT. Radiographic evaluation of patients with schistosomiasis. *Radiology*, Jan., 1975, 114, 31–37. (Address: Joseph F. Phillips, Department of Radiology, Duke University Medical Center, Durham, N. C. 27710.)

Schistosomiasis is a parasitic infection ranking second only to malaria in terms of world public health problems.

The World Health Organization estimates that 150 to 200 million people have a clinically significant infection. The disease is not a problem in the Continental United States, but it is endemic to Puerto Rico. The authors recently spent several months in Maceió, Alagoas, Brazil, where schistosomiasis mansoni is endemic. In this area, many villages have infection rates as high as 80 per cent. The case material is taken from this patient population.

The authors give excellent discussions of the life cycle of the *Schistosoma* and the pathophysiology of human infestation.

In schistosomiasis mansoni, a plain film roentgenogram of the abdomen in patients with advanced disease usually reveals massive splenomegaly without evidence of splenic calcification. Ascites may be evident in far advanced disease. Schistosoma haematobium is associated with a high frequency of bladder and ureteral calcifications which may be visualized on the plain film roentgenogram.

The chest roentgenogram is usually negative, but in the late stages of the disease it may occasionally be possible to recognize progressive dilatation of the azygos vein because of the development of large collateral channels running from the portal system into the hemiazygos system. Approximately 10 to 15 per cent of patients with schistosomiasis develop pulmonary hypertension. Granulomata may be seen as multiple small rounded densities scattered throughout both lung fields. The routine barium swallow may reveal unsuspected esophageal varices. Rarely, barium studies will demonstrate linear ulceration of the intestinal mucosa or the formation of polyps secondary to granulomatous response in the intestinal wall.

In schistosomiasis the urogram may reveal ureteral strictures or polypoid changes in the bladder wall. There is a predisposition to develop malignancy of the bladder in patients with schistosomiasis.

Liver-spleen scans with radioactive tracer material usually demonstrate homogeneous activity in a small liver and a markedly enlarged spleen. The splenomegaly is caused by portal hypertension and is also secondary to lymphoid hyperplasia caused by toxic reaction to the presence of the parasite.

Nine patients were studied preoperatively by panhepatic angiography and 14 postoperatively following splenorenal shunt. Thrombosis of the shunt and hepatic encephalopathy were common postoperative complications.

With these facts in mind, radiologists should be aware of the disease entity and be familiar with the roentgenologi: aspects of the problem.—E. J. Schoolar, M.D.

Rosenfield, Nancy, and Griscom, N. Thorne. Choledochal cysts: roentgenographic techniques. *Radiology*, Jan., 1975, 114, 113–119. (Address: Nancy Rosenfield, M.D., Department of Radiology, Beth Israel Hospital, Boston, Mass. 02215.)

Twenty-four cases of choledochal cysts were reviewed. Nine patients were under 1 year of age when diagnosed, and the oldest was 14.

The diagnosis of a choledochal cyst is difficult on clinical grounds alone. The triad of jaundice, pain and mass was present in only 1 patient, although all patients had at least 1 of these findings. Jaundice was the most frequent symptom. Pain may be the most common complaint in the adult.

The cases reviewed were over a 25 year period of time; therefore, the diagnostic approach changed greatly because of the development of radiological techniques. Only 7 cases were definitely diagnosed preoperatively. The diagnosis was made in 3 cases by I<sup>31</sup> rose bengal scanning. Two cases were diagnosed by intravenous cholangiography, 1 by oral cholecystography and 1 by Technetium<sup>99m</sup> sulfur colloid scanning followed by angiography. The highest percentage of definitive positive examinations was found in

the I<sup>131</sup> rose bengal scan in 3 of 4 cases, but the study most helpful in suggesting the diagnosis was the upper gastrointestinal series. Displacement of the stomach and duodenum on the upper gastrointestinal series is not a specific finding, but should suggest the diagnosis of a choledochal cyst when jaundice is present.

Treatment consists of surgical drainage. Twentyone surviving patients have been followed for 1 to 19 years. Eighteen patients are symptom-free, while 2 have recurrent jaundice and 1 has chronic pancreatitis.

The more frequent use of I<sup>131</sup> rose bengal scanning and ultrasound should increase the accuracy in the diagnosis of choledochal cysts.—J. L. Montgomery, M.D.

PIERETTI, RAPHAEL, AULDIST, ALEXANDER W., and STEPHENS, CLINTON A. Acute cholecystitis in children. Surg., Gynec. & Obst., Jan., 1975, 140, 16–18. (From: The Department of Surgery, Division of General Surgery, The Hospital for Sick Children, Toronto, Ontario, Canada.)

This is a rare disease in childhood and is seldom thought of in the differential diagnosis of abdominal pain in children.

This is a retrospective review of 16 children treated for acute cholecystitis at the Hospital for Sick Children, Toronto, over a period of 15 years. Definitive histologic confirmation was obtained in 13 patients and in 3 patients the diagnosis was based on clinical and roentgenographic evidence. Sex incidence was equal and age range was from 14 days to 14 years. Infections were noted in 4 patients, including a history of severe amniotitis in the mother of the 14 day old baby. Most common symptom was abdominal pain localized to the right upper abdominal quadrant and epigastric region in 12 of the patients. All patients had variable degrees of localized or diffuse tenderness guarding, and rebound tenderness and in 7 patients a tender mass was felt in the right upper quadrant. All patients had fever and 11 of 16 had leukocytosis. Serum bilirubin was elevated in 3 patients, alkaline phosphatase in 2 patients and serum amylase in 2 patients. Roentgenograms of the abdomen f 13 patients were not diagnostic lly helpful; however, oral and intravenous cholangiograms were obtained in 9 patients and no functioning of the gallbladder was observed. Agents used were bunamiodyl sodium orally, and iodipamide intravenously. Cholangiography and cholecystography were not done in other patients because the diagnosis was clinically obvious. Operative cholangiography was done through the cystic duct in 3 patients with no abnormality demonstrated. Four of 11 patients had cholecystectomy in the acute stage and 3 patients had mixed type calculi in inflamed gallbladders. There was no congenital abnormality of the biliary tract and no calculus was encountered in the common bile duct.

This survey still leaves the cause of cholecystitis in children in doubt. The instance of neonatal cholecystitis which followed amniotitis in the mother is unique. Although the incidence of calculi in children with cholecystitis has been less than in adults, the incidence is usually more than 50 per cent. Only 3 of 16 patients had calculi in this series. Cholecystography, either oral or intravenous, is a definite diagnostic aid and should always be obtained, although lack of function after oral or intravenous administration of contrast material is not necessarily abnormal.

The authors recommend operative choledochography in children with jaundice, since this may prevent unnecessary exploration and drainage of the common bile duct.—Lionel W. Young, M.D.

Mulder, H., and Te Velde, J. Colitis cystica profunda: pseudo-tumours in the rectum. Radiol. clin. et biol., 1974, 43, 529-539. (Address: H. Mulder, M.D., Department of Radiology, University Hospital, Leiden, The Netherlands.)

Colitis cystica profunda, also designated as "harmatomatous polyps of the rectum," and "solitary ulcer of the rectum," is a rare lesion not previously described in the radiologic literature. It afflicts individuals in their twenties and thirties. The patients present with rectal bleeding, frequent bowel movements, an occasionally with weight loss. Symptoms are refractory to medical treatment. The etiology is obscure.

Double contrast barium enema examination shows broad based, submucosal, polypoid lesions, which project intraluminally, efface mucosal folds, and may ulcerate. The surrounding rectal wall appears thickened, and has lost contractility. The opposite wall may show persistent spasm. Proctoscopic examination identifies a soft, ill-defined submucosal lesion, sometimes ulcerated. They occur most commonly in the anterior rectal wall. Pathologically, mucus filled submucosal benign cysts are surrounded by varying degree of acute and chronic inflammatory reaction and fibrosis. Superficial ulcerations may communicate with the cysts.

The authors present 2 cases which emphasize the clinical, radiographic and proctoscopic resemblance of colitis cystica profunda to malignancies of the rectum. Excisional biopsy with detailed microscopic examination is urged to avoid inadvertent ablative cancer surgery.—Adele R. Altman, M.D.

#### GENITOURINARY SYSTEM

Pollack, Howard M., Goldberg, Barry B., Morales, José O., and Bogash, Morton. A systematized approach to the differential diagnosis of renal masses. *Radiology*, Dec., 1974, 113, 653-659. (Address: Howard M. Pollack, M.D., Department of Radiology, Episcopal Hospital, Front Street and Lehigh Avenue, Philadelphia, Pa. 19125.)

A total of 202 adult patients (206 masses) was studied by means of a diagnostic protocol organized as a flow chart. The flow chart was designed to select the most appropriate diagnostic studies in sequence without duplication and to minimize the morbidity and hospital cost to the patient.

Excretory urography was the initial radiographic evaluation method in all cases. In only 2 lesions can excretory urography differentiate cysts from tumors. A renal hamartoma (angiomyolipoma) may demonstrate radiolucency on the plain abdominal films due to its fat content and an occasional renal-cell carcinoma may demonstrate mottled intratumoral calcification. These patients were next studied by arteriography.

If a renal pseudotumor is suggested on the urogram, radionuclide imaging using Hg<sup>197</sup>-chlormerodrin is the next diagnostic step. If the renal scan is negative, the work-up is considered complete with the diagnosis "normal variant." If the renal scan is abnormal, a Technetium<sup>99m</sup> flow study is sometimes also performed. If the renal scan is abnormal and the flow study is abnormal, indicating increased vascularity, the patient is next evaluated by arteriography. If a renal scan alone is performed, and it is abnormal or if the renal scan is abnormal and no flow study is performed, ultrasound is the next diagnostic study.

Those patients with a definite mass on the urogram are next studied with ultrasound. On ultrasonography, one of 3 patterns may be seen. The pattern may by cystic, solid, or complex. The cystic lesion on ultrasonography was then studied by nephrotomography. Lesions other than cysts were studied by arteriography. If nephrotomography revealed a cyst, a cyst puncture was performed if possible. The aspirated fluid was examined for malignant cells, fat and blood. If the fluid was negative on these studies and contrast material placed in the cyst following aspiration revealed a smooth wall on multiple radiographic views, the work-up was considered complete and the diagnosis of "renal cyst" was made. Any abnormalities of the fluid or irregularity of the wall must be further evaluated with arteriography or considered for exploration.

All complex lesions were studied by nephrotomography. A typical cyst on nephrotomography then underwent cyst puncture with examination of the fluid and the walls of the cyst as outlined above. All other lesions were studied by arteriography.

A solid pattern on nephrosonography was next evaluated with arteriography. A typical tumor pattern completed the evaluation. All other lesions underwent nephrotomography. A lesion with a thick wall was interpreted as a probable tumor. A thinwalled lesion was further studied by cyst puncture.

This series of 206 masses included 143 cysts and 13 tumors. A wide variety of other lesions were also

seen. In this series, no tumors or other serious lesions were overlooked. Precautionary surgery was necessary in 20 cases (10 per cent) for a definite diagnosis; one of these patients had a neoplasm. Renal angiography was used in 26 patients (13 per cent). Sixty-six patients underwent cyst puncture. Only 5 patients underwent the complete series of nephrosonography, nephrotomography, needle puncture, and arteriography. The diagnostic evaluation could be performed entirely on an outpatient basis in more than 85 per cent of the cases. Not uncommonly all studies were completed within half a day.—J. F. Bergstrom, M.D.

#### SKELETAL SYSTEM

Schneider, Harold J., King, Athena Y., Bronson, Jeffrey L., and Miller, Edward H. Stress injuries and developmental change of lower extremities in ballet dancers. *Radiology*, Dec., 1974, 113, 627–632. (Address: Harold J. Schneider, M.D., Department of Radiology, Christian R. Holmes Hospital, Eden and Bethesda Avenue, Cincinnati, Ohio 45219.)

Frequent injuries among members of a professional ballet company prompted a radiographic survey of the hips and lower extremities in 52 such dancers. The authors cite a series of stress-induced changes which they feel are unique and consistent enough to identify the classical ballet dancer.

Specific roentgenographic findings seen include: stress fractures of the femora, tibiae and fibulae; prominent dorsal notch of the talar neck with or without an accompanying dorsal exostosis of the talar head; and cortical thickening of the long bones and of one or more of the first 3 metatarsals. The tibial fractures have a predilection for the anterior midshaft, in contrast to stress fractures in military personnel and athletes which are typically in the upper or lower tibial shaft.

A number of nonspecific findings which occurred with much less frequency are also described. Age and dancing experience did not appear to correlate with severity of findings.—William I. Dittman, M.D.

AADALEN, RICHARD J., WEINER, DENNIS S., HOYT, WALTER, and HERNDON, CHARLES H. Acute slipped capital femoral epiphysis. J. Bone & Joint Surg., Oct., 1974, 56-A, 1473-1487. (Address: Richard J. Aadalen, M.D., 825 South Eighth Street, Minneapolis, Minn. 55404.)

Fifty cases of acute slipped capital femoral epiphysis were reviewed from the University Hospitals of Cleveland and Children's Hospital of Akron. In 47 treated by manipulative reduction and epiphyseodesis, pin fixation, or both, 7 developed avascular necrosis (15 per cent). In 19 treated by manipulative reduction, epiphyseodesis, and plaster immobiliza-

tion, avascular necrosis occurred in 1 (5 per cent) and 17 (90 per cent) had satisfactory functional results. In 16 treated by manipulative reduction and pin fixation, 3 (25 per cent) developed avascular necrosis and 12 (75 per cent) had satisfactory functional results. Avascular necrosis occurred in no patients of 8 treated by manipulative reduction within 24 hours of the onset of acute symptoms.

Criteria for the study were: (1) acute onset of severe pain less than 3 weeks prior to admission; (2) hip pain accompanied by external rotation deformity, limitation of motion, and inability to bear weight on the affected extremity; (3) roentgenographic evidence of an epiphyseal displacement; and (4) reduction of the displacement following gentle manipulation under general anesthesia. Displacement easily reduced is evidence of acute slipping. The article contains a review of the literature of avascular necrosis in acute slipped capital femoral epiphysis.

The nature of injury may be observed during intracapsular open reduction or epiphyseodesis. A tear in the periosteal sleeve of the femoral neck along its anterosuperior aspect can be observed. In addition separation of the epiphysis is present, but the periosteal sleeve remains intact along the posterior inferior aspect of the neck. Retinacular vessels are disrupted at the time of the acute displacement. Histopathology of epiphyseolysis is similar in acute and chronic cases, there being a general disorganization of the epiphyseal plate with disruption of the columnation and clustering of cartilage cells, clefts and septa in the matrix of the plate and areas where the epiphyseal cartilage has been pushed into the metaphysis.

The full group of cases were identified in Group I—manipulative reduction and plaster immobilization; Group II—manipulative reduction and internal fixation; Group III—manipulative reduction, epiphyseodesis, and plaster immobilization for 6 to 8 weeks; Group IV—manipulative reduction, epiphyseodesis, and internal fixation. The interval between the acute displacement and definite treatment is subgrouped as follows: Group A—less than 24 hours; Group B—24 to 48 hours; Group C—48 to 72 hours; Group D—more than 72 hours.

Results of treatment were evaluated both clinically and roentgenographically, utilizing the evaluation criteria of Heyman and Herndon: excellent—normal range of hip motion, no limp, and no pain; good—no limp, no pain, slight limitation of internal rotation, but internal rotation beyond neutral; fair—no limp, no pain, slight limitation of abduction as well as internal rotation; poor—mild limp, slight pain after strenuous exercise, and slight limitation of internal rotation, abduction, and flexion; failure—limp, pain on activity, and marked limitation of motion requiring reconstructive surgery or demonstrating progressive roentgenographic changes in the hip. Significantly, avascular necrosis in acute slipped capital femoral epiphysis occurs only in boys, perhaps re-

lated to the greater incidence of anastomosis between upper and lower capital vessels in girls than boys.

The 3 main groups of arterial supply to the femoral head are upper capital, lower capital and ligamentous arteries.

In pigment rich ("black") patients with chronic slipped capital femoral epiphysis there is a greater incidence of acute chondrolysis and more avascular necrosis, but it is not clear from this series that this phenomenon occurs in acute cases. Severe initial displacement of the epiphysis does not necessarily indicate that avascular necrosis will develop; however, the amount of displacement may affect results. Gentle manipulation reduction is indicated as treatment, since force may increase the incidence of avascular necrosis, therefore reduction by traction has been advocated.

The authors advocate use of manipulative reduction and epiphyseodesis, since the functional and roentgenographic evaluations indicate that results are comparable with results obtained by other closed methods and internal fixation.—Lionel W. Young, M.D.

ZINGG, E. J., Fuchs, W. A., HÉRITIER, P., and GÖTHLIN, J. Lymphography in carcinoma of the prostate. *Brit. J. Urol.*, Oct., 1974, 46, 549–554. (From: The Departments of Urology and Diagnostic Radiology, Inselspital, University Hospital of Berne, Switzerland.)

Sixty consecutive patients with histologic and/or cytologic verified carcinoma of the prostate underwent examination.

In Stage I disease (malignant lesions limited to the prostate and probably occult) there was I case with lymphographic findings indicating metastatic spread. The 6 normal lymphangiograms were proved to be correct by subsequent lymphadenectomy. In clinical Stage II disease (rectal examination showing the lesions to be clinical and extending throughout most of the prostate) 7 of 16 patients had positive lymphangiograms. In clinical Stage III disease (extension of tumor beyond the prostatic capsule but without evidence of metastases), 23 of 34 patients showed an abnormal lymphangiogram due to metastases.

On initial clinical staging with digital rectal examination, 7 patients were classified as Stage I, 19 patients as Stage II, and 34 as Stage III. With integration of the results of digital rectal examination and subsequent lymphography and radiographic and/or isotopic examinations of the bone, the final staging classification of the 60 patients was as follows: Stage I-6 cases; Stage II, 8 cases; Stage III, 5 cases; and Stage IV (evidence of distant metastases regardless of rectal findings), 41 cases. Thus, digital rectal examination can be seen to underestimate the extent of disease.

The lymphatic system is an important route for

metastatic spread of prostatic carcinoma. The 50 per cent rate of positive lymphangiograms in their case material of 60 patients clearly demonstrates this. The more advanced stage tumors were found to metastasize to lymph nodes more frequently since of 26 cases with Stage I and II disease on digital rectal examination, only 8 (30 per cent) cases had positive lymphangiograms, whereas in the 34 patients with Stage III disease, 23 positive lymphangiograms (68 per cent) were encountered. Unilateral involvement of the external iliac lymph nodes was present in 12 cases and bilateral iliac lymph node metastatic defects were found in 3 cases. An additional 3 cases showed only abnormal lymph nodes in the aortic chain-unilateral in 2 and bilateral in 1. Thirteen cases showed abnormal iliac and aortic lymph node groups of various combinations either unilateral, bilateral or crossover.

The clinical value of lymphography, utilizing the following strict diagnostic criteria of the authors, resulted in an accuracy rate of 85-90 per cent. These criteria were: a. solitary or multiple well-demarcated filling defects of 10 mm. or larger in regional lymph nodes, since filling defects of smaller size do not have the same diagnostic quality indicating malignancy; and b. obliteration and collateral circulation reflecting lymphatic obstruction.

The following changes were not found to be significant in the diagnosis of metastases: a. delayed contrast medium filling of lymph vessels 24 hours following injection of contrast material, since this is mainly due to technical factors and cannot be regarded as a sign of lymphatic obstruction; b. increase of lymph node size and a globular shape of lymph nodes being unreliable signs of lymph node metastases; and c. dislocation of lymphatics and lymph nodes is also inconclusive since elongation of the concomitant arteries due to atherosclerosis will frequently lead to displacement of iliac and/or aortic lymphatic systems.

Small lymphatic metastases may not be recognized by lymphography, since the small metastatic foci are difficult to detect because of restricted resolution of the method of lymphography and the great variation of lymph nodes with their physiological fibrolipomatous filling defects. A negative lymphangiogram, therefore, does not exclude malignant disease in regional nodes. However, absence of involvement of regional lymph nodes on lymphangiography does exclude advanced disease.—Richard C. Pfister, M.D.

#### BLOOD AND LYMPH SYSTEM

Macpherson, R. I. The radiologic manifestations of Henoch-Schoenlein purpura. J. Canad. A. Radiologists, Dec., 1974, 25, 275–281. (From: Department of Radiology, The Children's Hospital of Winnipeg and University of Manitoba, Winnipeg, Manitoba, Canada.)

Five cases of Henoch-Schoenlein purpura (anaphylactoid purpura) are reported for the purposes of emphasizing the radiologic demonstration of localized mucosal and submucosal edema and/or hemorrhage involving bowel or bladder including associated complications.

In the majority of cases of Henoch-Schoenlein purpura, radiologic findings are either absent or nonspecific and consequently the majority of cases never come to the radiologist's attention.

The article reviews the clinical, radiologic and where possible the pathologic features found in 90 consecutive cases of Henoch-Schoenlein purpura seen at the Children's Hospital of Winnipeg over a 12 year period. The diagnosis of Henoch-Schoenlein purpura was accepted in children who had non-thrombocytopenic purpura plus at least 1 of the following: arthralgia, abdominal pain or abnormalities of the urinary sediment.

There were 39 males and 41 females and ages ranged from 10 months to 15 years. All cases had purpura, arthralgia was present in 75 per cent, and gastrointestinal signs and symptoms were present in 56 per cent. Radiologically the gastrointestinal manifestations and complications proved most challenging. Four of 12 patients had radiologic evidence of small bowel obstruction. One patient had radiologic and clinical evidence of ascites. Five patients had localized areas of coarse thickened mucosal folds and irregular mural filling defects. Two of 4 barium enema examinations were abnormal, one with ileoileal intussusception and another irregular polypoid mural filling defects in the terminal ileum. Twentyeight per cent of patients had abnormalities in urinary sediment. One of 6 intravenous urograms was abnormal, there being an irregular mural filling defect in the urinary bladder; and 1 of 3 cystograms was abnormal: the same bladder defect as observed in the urogram. Thirty-nine patients (43 per cent) had chest roentgenograms in 4 of which abnormalities were noted. One had right middle lobar pneumonia and the other 3 moderate-sized pleural effusions.

The author concludes that radiology has little role in the primary diagnosis of Henoch-Schoenlein purpura; however, some distinctive complications of Henoch-Schoenlein purpura are best demonstrated by roentgenography. Underlying pathology of the lesions is a vasculitis affecting small vessels. Vasculitis causes edema and hemorrhage into the mucosas and submucosas of the gastrointestinal tract. These are the bases for localized areas of coarse mucosal thickening or the irregular polypoid filling defects (thumbprinting or pseudotumors) on upper gastrointestinal and barium enema examinations. The same roentgenographic findings may be caused by localized intramural hemorrhage from trauma, anticoagulant therapy or other bleeding disorders. Lymphomas, other tumors and regional enteritis are nonhemorrhagic conditions that may have these findings. In the complications involving the urinary system, those that progress to malignant hypertension, chronic renal failure or the nephrotic syndrome may have changes in renal size, shape and function demonstrable on urography. However, in the series reviewed by the author the incidence of renal complications is much less than gastrointestinal complications. To the author's knowledge the localized intramural hematoma of the urinary bladder has not been reported before.—Lionel W. Young, M.D.

HIGGINS, CHARLES B., and REINKE, ROBERT T. Nonsyphilitic etiology of linear calcification of the ascending aorta. *Radiology*, Dec., 1974, 113, 609–613. (Address: Charles B. Higgins, M.D., Department of Radiology, University Hospital, 225 West Dickinson Street, San Diego, Calif. 92103.)

Years ago linear calcification in the ascending aorta was considered nearly pathognomonic of luetic aortitis.

Since the incidence of syphilis, particularly the advanced forms of cardiovascular syphilis, has decreased considerably in the past 2 to 3 decades, the assumption that ascending aortic calcification is indicative in most instances of syphilitic aortitis may no longer be valid. The increase in age of the population with the attendant increase in the incidence of the more severe forms of atherosclerosis raises the possibility of encountering non-luetic forms of ascending aortic calcification more commonly.

The authors studied in detail 20 consecutive patients in whom distinct linear calcification in the ascending aorta was observed roentgenographically. VDRL and FTA-ABS tests were done on all these patients and each was questioned in detail in order to elicit a history of syphilis in the past. In only 5 of these patients was the presence of syphilis confirmed.

The authors conclude that in the non-syphilitic group, the ascending aortic calcification was presumably due to atherosclerosis. These patients were also found to have a high incidence of aortic valvular disease which was thought to be a contributing factor to the formation of calcification in the ascending aorta.

It is the feeling of the authors from this study that ascending aortic calcification can no longer be considered diagnostic or pathognomonic of luetic aortitis.—Donald N. Dysart, M.D.

Lande, Adam, and Rossi, Plinio. The value of total aortography in the diagnosis of Takayasu's arteritis. *Radiology*, Feb., 1975, 114, 287–297. (Address: Adam Lande, M.D., Department of Radiology, Metropolitan Hospital, 1901 First Avenue, New York, N. Y. 10029.)

During the last 2 decades numerous separate reports have drawn attention to the existence of a previously unrecognized form of arteritis involving the

aorta and its branches, and the pulmonary arteries. This syndrome has been given a variety of names: Takayasu's arteritis; nonsyphilitic or nonspecific arteritis; aortitis syndrome; idiopathic arteritis; pulseless disease; aortic arch syndrome; and the middle aortic syndrome. The authors present a detailed review of 23 cases of Takayasu's arteritis and emphasize the 2 clinical stages of the disease: (I) early systemic and (2) late occlusive, as well as the value of total angiography in the diagnosis of this disease.

Takayasu's arteritis is believed to be an autoimmune disease, and may begin with acute generalized signs and symptoms. In its classical form, the disease consists of an early systemic and a late occlusive phase. The early prepulseless phase is characterized by such diverse signs and symptoms as fever, night sweats, arthralgia, arthritis, myalgia, pain, etc. A latent or silent period follows which may vary from days to many years before the pulseless phase appears which takes the form of variable ischemic manifestations secondary to arterial occlusion.

The spectrum of histologic change is closely related to the activity of the disease. During the active stage, diffuse granulation tissue is accompanied by an inflammatory infiltrate of plasma cells and lymphocytes which invade and destroy the functional elements of the arterial wall. In later stages, fibrosis predominates and the cellular exudate is scanty or absent. The degree of secondary atherosclerosis may at times be so severe as to totally obscure the underlying intimal changes of arteritis. Because of the protean clinical manifestations of Takayasu's arteritis and the frequently misleading pathologic appearance of the aorta, arteriography has assumed primary diagnostic importance. The configuration of the diseased aorta as provided by total aortography is highly characteristic and can identify the condition even in the presence of secondary atherosclerosis.

Three basic arteriographic patterns were observed in their patients: (a) varying degrees of aortic and arterial narrowing; (b) saccular and fusiform aneurysms; and (c) various combinations of the two. The earliest detectable change at arteriography may be a localized narrowing or irregularity of the aortic wall. Although moderate narrowings may be completely asymptomatic, they represent an important arteriographic landmark of Takayasu'a arteritis. The aortic constriction can be short and segmental, or long and diffuse, and may involve the thoracic or abdominal aorta or both. The elongate coarctations of the thoracic aorta frequently originate distal to the left subclavian artery and gradually taper toward the diaphragm. The appearance is quite characteristic and has been described as the "rat-tail" thoracic aorta. The aneurysm formation observed may be fusiform or saccular, but frequently the aortic wall is diffusely dilated with irregular contours. In some patients, a saccular aneurysm may be superimposed on

diffuse aortic dilatation. Skipped areas of aortic involvement, in which aneurysms and narrowing alternate with normal segments, are most characteristic of Takayasu's arteritis.

The authors, in summary, emphasize that Takayasu's arteritis is a disease of protean manifestations, probably autoimmune in nature, and extremely variable in form and severity in both the early systemic prepulseless phase and the late occlusive phase. Total aortography is of paramount diagnostic importance, for it provides a composite picture of the pathologic changes of the aorta and its branches, both symptomatic and asymptomatic.—E. B. Best, M.D.

DARDIK, IRVING I., IBRAHIM, IBRAHIM M., SPRAYREGEN, SEYMOUR, VEITH, FRANK, and DARDIK, HERBERT. Routine intraoperative angiography: an essential adjunct in vascular surgery. A.M.A. Arch. Surg., Feb., 1975, 110, 184–190. (Address: Herbert Dardik, M.D., 1555 Center Avenue, Fort Lee, N. J. 07024.)

Routine intraoperative angiography was performed during 155 arterial reconstructed procedures, including bypass, endoarterectomy, embolectomy, thrombectomy, primary reconstruction and angioplasty.

The procedure was performed after completing the vascular repair by manually injecting 20-30 ml. of contrast material into the artery below the site of reconstruction. Roentgenograms were obtained during the period of injection.

In 27 of the patients, abnormalities were identified which required additional surgical correction. These included technical errors of the accumulation of platelet or atherosclerotic thrombus material at the suture line.

The authors conclude that intraoperative angiography is an essential adjunct to assess vascular surgery, but is not a substitute for good, routine preoperative angiography.—Robert I. White, Jr., M.D.

#### RADIATION THERAPY

BELGRAD, RICHARD, ELBADAWI, NABILA, and RUBIN, PHILIP. Uterine sarcoma. Radiology, Jan., 1975, 114, 181–188. (Address: Philip Rubin, M.D., Division of Radiation Oncology, The University of Rochester School of Medicine and Dentistry, 260 Crittenden Boulevard, Rochester, N. Y. 14642.)

Uterine sarcomas are rare tumors. They comprise less than 3 per cent of uterine corpus malignancies. Recent modification of the classification schema and careful pathologic analysis suggested that the response to surgery or irradiation is as much a function of the histologic characteristics as of the therapy per se. Consequently, the authors decided to analyze a group of uterine sarcoma cases to determine the

effectiveness of radiotherapy in the different subgroups.

The study is a retrospective unrandomized review of 34 cases of uterine sarcoma treated at Strong Memorial Hospital between 1955 and 1972. The patients were staged according to the clinical staging for malignant tumors of the corpus uteri of the UICC-AJCCS. The histologic classification utilized basically 4 criteria: pure or mixed, and homologous and heterologous. Pure sarcomas contain only a single sarcomatous element, while mixed sarcomas contain more than one. Homologous tumors contain the neoplastic counterpart of mesodermal tissue normally found within the uterus. Heterologous tumors contain mesenchymal elements not ordinarily found in the uterus (e.g., cartilage, fat, etc.). Adenocarcinoma and squamous carcinoma can be present, but do not contribute to the above typing. Of the 34 cases in this series, 19 were pure homologous types and 15 were heterologous tumors.

Analysis of the total group revealed an age range from 25 to 89 years (most patients were older). The survival data suggested that 2 years was the critical period for recurrence. If patients survived recurrencefree beyond this time, the prognosis was usually good. Staging seemed to be of limited value in predicting outcome. No patient in any histologic group who had a recurrence was subsequently cured by either surgery or irradiation. Surgery is sufficient treatment in most cases of leiomyosarcoma, especially when discovered incidentally. Endometrial stromal sarcoma patients are best managed by combining surgery and irradiation. Mixed mesodermal tumors are highly malignant and respond poorly to any form of treatment, although prompt surgery followed by postoperative pelvic irradiation should be tried.

It is concluded that adjuvant pelvic radiotherapy be offered to most patients with uterine sarcomas except those with early, low grade leiomyosarcomas. A vaginal obturator is also recommended if preoperative radiotherapy has been used and there is concern about the likelihood of vaginal recurrence following surgery.

Excellent illustrations and tables supplement this article.—Paul M. Kroening, M.D.

#### **RADIOISOTOPES**

PISTENMA, DAVID A., McDougall, I. Ross, and Kriss, Joseph P. Screening for bone metastases: are only scans necessary? J.A.M.A., Jan., 1975, 231, 46-50. (Address: David A. Pistenma, M.D., Division of Nuclear Medicine, Stanford University School of Medicine, Stanford, Calif. 94305.)

Bone scans with technetium labeled diphosphonate on 200 consecutive patients with malignant disease demonstrated by biopsy were compared to metastatic bone survey.

Patients with primary tumors involving breast, prostate, lung, lymphoma, bone, gynecologic, gastro-intestinal, endocrine, and other organs were evaluated.

Bone scan and roentgenogram were both abnormal in 26 per cent, scan and roentgenogram were both normal in 38 per cent. The scan was abnormal and roentgenogram normal in 28.5 per cent, whereas the scan was negative and roentgenogram abnormal in only 1.5 per cent.

This report substantiates the results of previous investigators, who have suggested that diphosphonate scans are more sensitive screening for bone metastases than roentgenograms. Bone roentgenograms should be used for further evaluation of clinically suspicious sites with normal scans and for abnormal sites on scans that are not suspected to be due to tumor.—H. William Strauss, M.D.

#### **ULTRASOUND**

Hancke, Soren, Holm, Hans Henrik, and Koch, Finn. Ultrasonically guided percutaneous fine needle biopsy of the pancreas. Surg., Gynec. & Obst., March, 1975, 140, 361–364. (From: The Ultrasonic Laboratory, The Department of Surgery H., and The Department of Pathology, Gentofte Hospital, Hellerup, Denmark.)

Ultrasonic scanning of the upper abdomen for identification of pancreatic masses is atraumatic and carries no risk. The technique has now been extended to provide a precise guide for percutaneous puncture of a demonstrated mass.

Eighty patients, culled from approximately 410, had proven pancreatic disease. Of these, 36 were suspected of harboring a malignancy. Percutaneous needle biopsies were performed in 25. In 17, the examination was unequivocably positive, the aspirates containing easily recognizable malignant cells. In 2 patients, the tumors were so hard, they could not be punctured by a fine flexible needle. There was I false negative study. One examination was technically unsatisfactory. Four needle biopsies yielded normal cells, the subsequent diagnosis was chronic pancreatitis.

The reader is referred to the original article for a detailed description of the technique. In principle, after the pancreatic mass has been located on the oscilloscope screen in appropriate projection, a guided percutaneous biopsy is performed using a special, hollow, ultrasonic transducer, through which a fine flexible puncture needle can be introduced. The needle will follow the path of the sound beam emitted from the transducer. Its exact position and depth can be read from the picture on the screen. Multiple aspirations, in different directions, can be accom-

plished with one puncture. The smallest tumor biopsied measured  $2\times 2$  cm., the largest  $6\times 6$  cm. There were no immediate complications after puncture and aspiration in this series.

The authors conclude, in this preliminary report, that the combination of ultrasonic scanning and ultrasonic guided percutaneous fine needle aspiration is an important adjunct in the management of pancreatic disease. However, they suggest that more investigation is needed to confirm the sensitivity of ultrasonic scanning and the accuracy of cytologic examination of pancreatic aspirates.—Adele R. Altman, M.D.

Walls, William J., Gonzalez, Giomar, Martin, Norman L., and Templeton, Arch W. B-scan ultrasound evaluation of the pancreas: advantages and accuracy compared to other diagnostic techniques. *Radiology*, Jan., 1975, 114, 127–134. (Address: William J. Walls, M.D., Department of Diagnostic Radiology, University of Kansas Medical Center, 39th Street and Rainbow Boulevard, Kansas City, Kan. 66103.)

The authors compare the diagnostic accuracy of ultrasonic B scanning to other diagnostic modalities such as upper gastrointestinal series, isotopic pancreatic scanning, and arteriography in patients with suspected pancreatic disease. Ultrasound examinations of the pancreas were performed in 285 patients. Diagnosis was proved in 94. Upper gastrointestinal examinations were performed in 76 of the 94 patients with proved diagnoses; 37 had isotopic scans and 11 were examined angiographically.

Abnormality was detected in 58 of the 76 patients having upper gastrointestinal series for 70 per cent accuracy. Isotopic scanning was 73 per cent accurate in detecting an abnormality. Arteriography had an accuracy rate of 82 per cent in studies performed on 11 patients. In 94 of the proved cases having had ultrasound scanning, a correct diagnosis was made in 79 for an accuracy of 84 per cent.

In the ultrasound examinations, the patients were scanned in routine transverse and longitudinal directions plus additional transverse scans with the transducer angled cephalad 20 degrees and, also, angled-oblique views scanned parallel to the right costal margin angled cephalad 20 degrees.

Carcinoma of the pancreas presents echographically as a solid mass causing attenuation of the beam. Because of the attenuation, great care must be taken to define the posterior wall. Metastatic neoplasms cannot be distinguished from primary neoplasms. In pancreatitis, ultrasound is very helpful, particularly when the clinical picture is not entirely clear. Echographic diagnosis of pancreatitis is easiest in the acute phase of the disease when the pancreas is enlarged and edematous. Pancreatic pseudocysts, because of their cystic character, are best detected by

ultrasound. Pseudocyst formation in pancreatitis can be demonstrated early. Ultrasound is also helpful in ruling out suspected pancreatic disease by demonstrating masses outside the region of the pancreas.

Although the upper gastrointestinal series is a necessary complement, ultrasound scanning is regarded as the primary method for detecting and differentiating possible pancreatic disease. It provides a more specific diagnosis than either the upper gastrointesti-

nal series or isotopic scanning.

Ultrasound is particularly valuable as a screening examination early in the work-up of a patient with suspected pancreatic disease. It can be performed with relative ease, limited expense, and no discomfort or known morbidity to the patient.—John M. Stoebner, M.D.

Doust, Bruce D., Baum, Janet K., Maklad, NABIL F., and DOUST, VIVIENNE L. Ultrasonic evaluation of pleural opacities. Radiology, Jan., 1975, 114, 135-140. (Address: Nabil F. Maklad, M.D., Department of Radiology, Wayne County General Hospital, Eloise, Mich. 48132.)

The differentiation between pleural fluid and other conditions by the use of A-mode and B-mode ultrasound was examined by the authors.

The study utilized 41 patients with opacifications

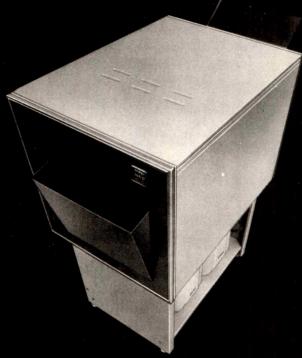
on chest roentgenograms.

Twenty-five out of 27 patients with pleural effusion or empyema were diagnosed accurately. The correct diagnosis was made in 13 out of 14 patients with pleural thickening and/or pulmonary consolidation.

In order to avoid subdiaphragmatic needle placement, the diaphragm was identified utilizing M-mode ultrasound. Pleural effusions 1 cm. or less could not be detected probably due to rib reverberations.-Robert F. Kuhnhein, M.D.



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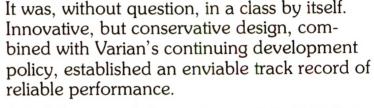
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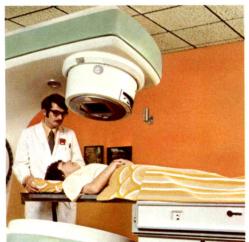
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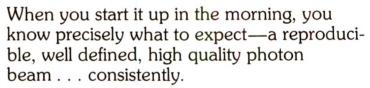
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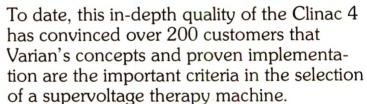




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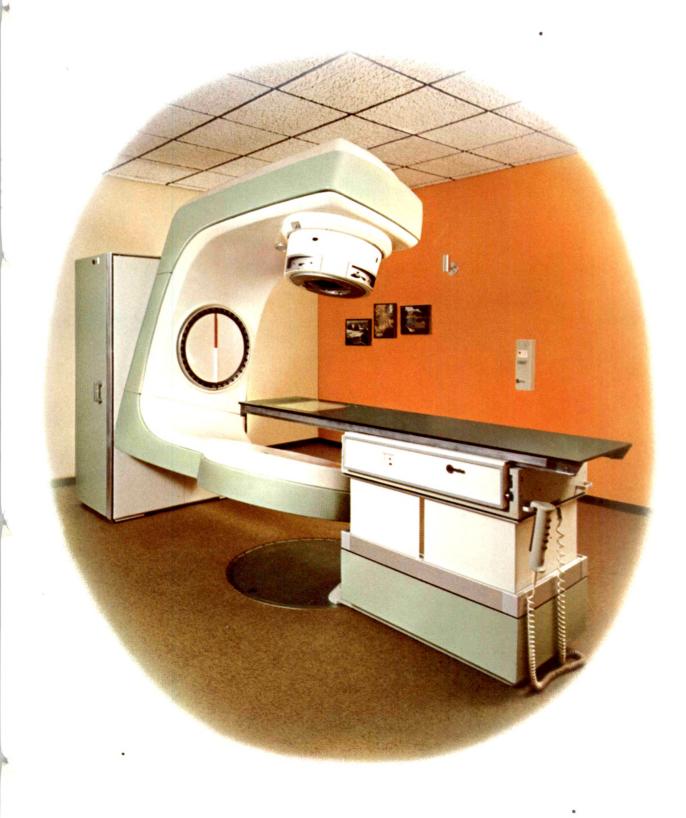
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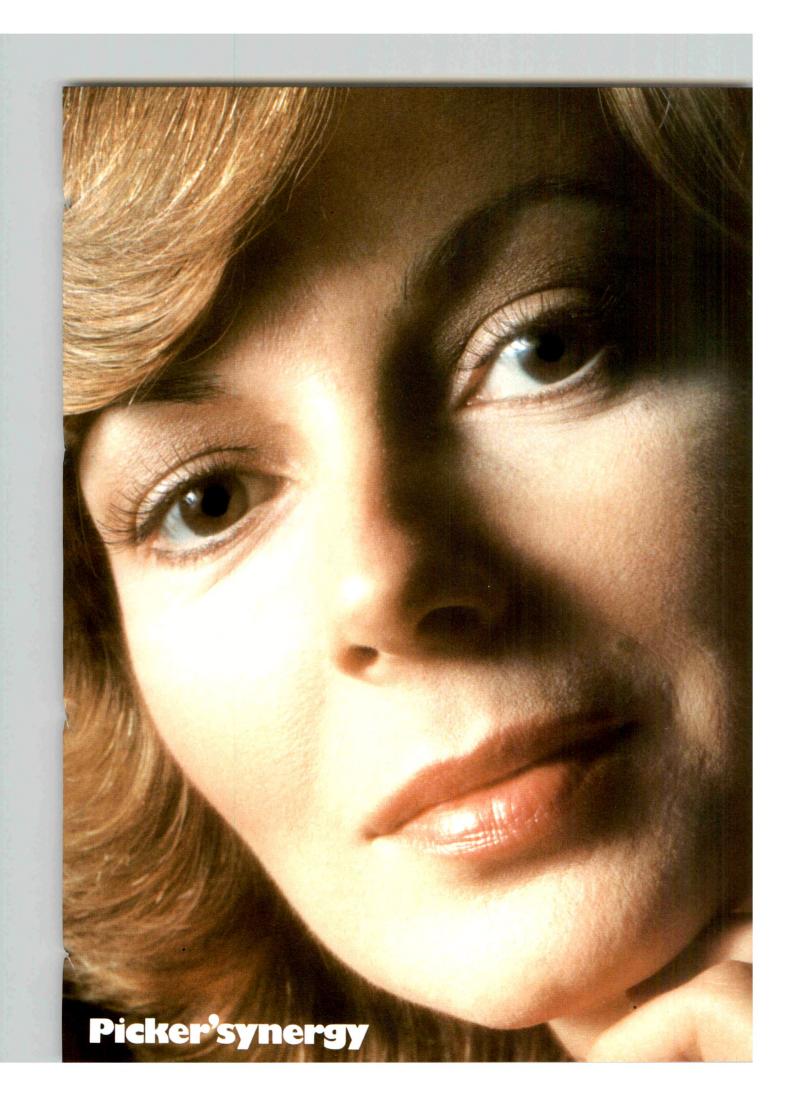
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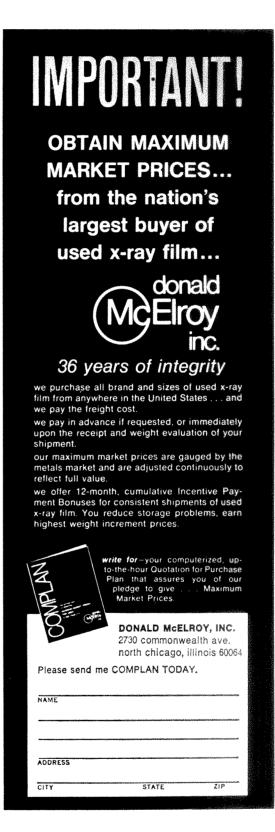
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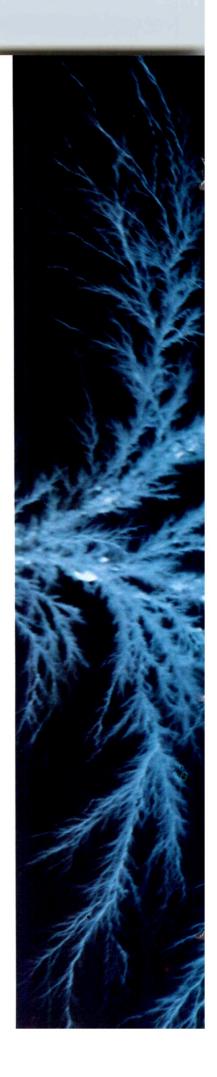
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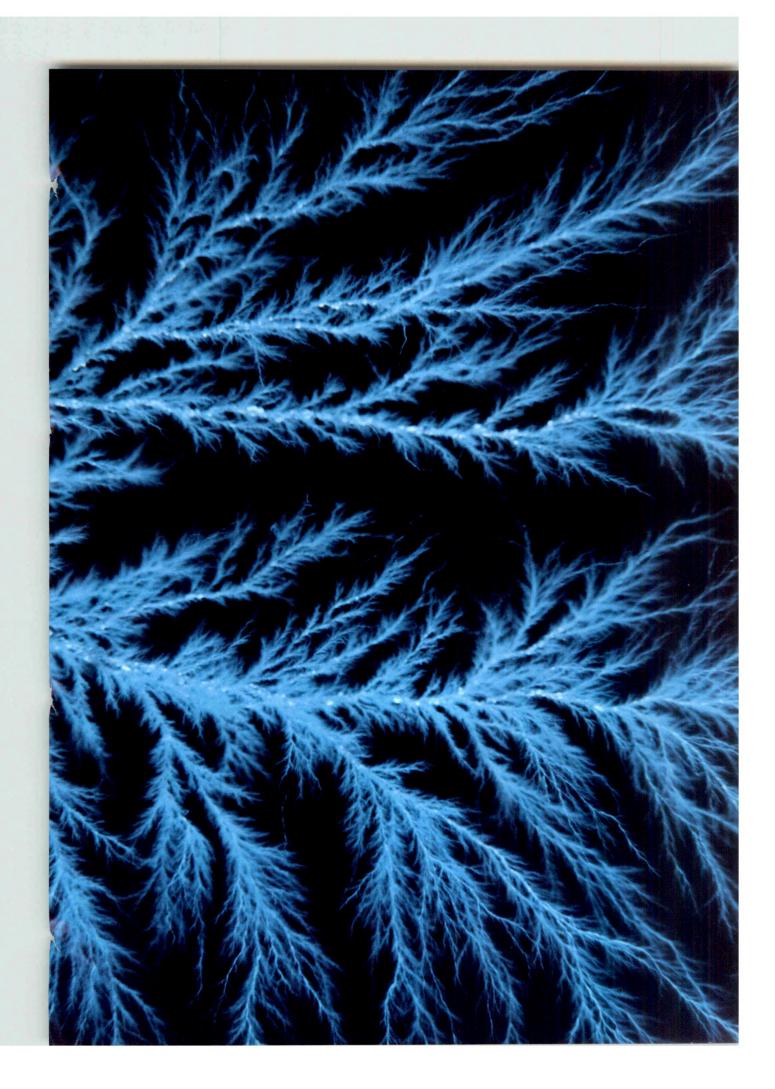
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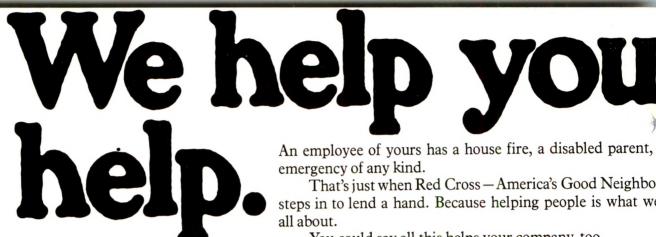
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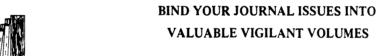
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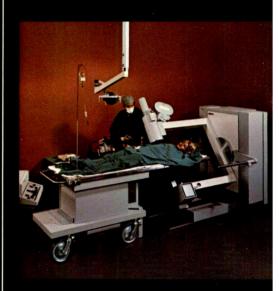
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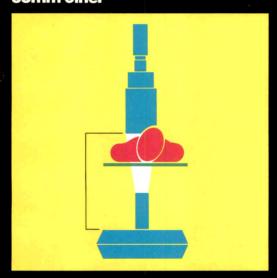
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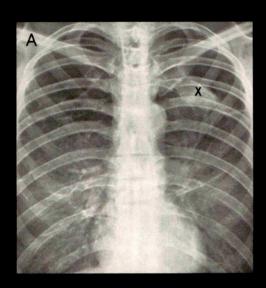


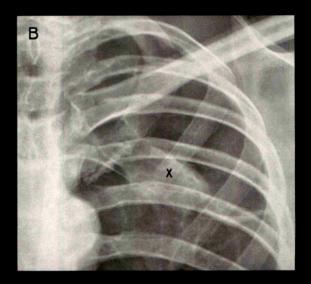


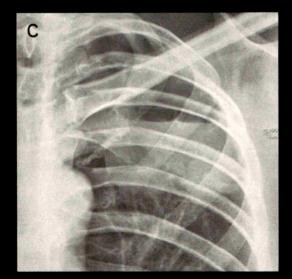
# Primary Squamous Cell Carcinoma of the Lung

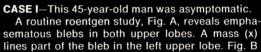
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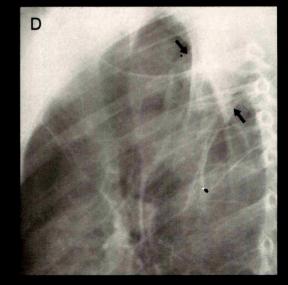




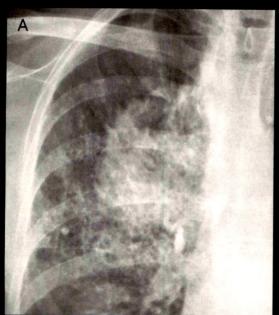


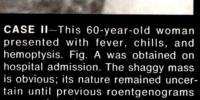
demonstrates the mass more closely.

Three months later, Fig. C, a fluid level obscures the mass. Fortunately, it is well demonstrated (arrows) in the lateral exposure, Fig. D.

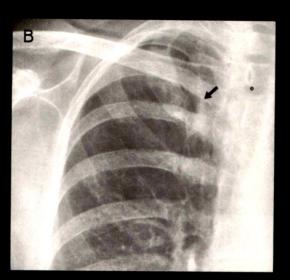


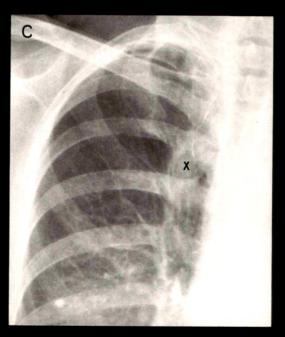
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were reviewed. In retrospect, Fig. B, a chest study exposed 16 months prior to Fig. A revealed a linear mass in the right upper lobe (arrow). This mass was even more obvious two months later, Fig. C(x).







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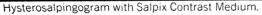


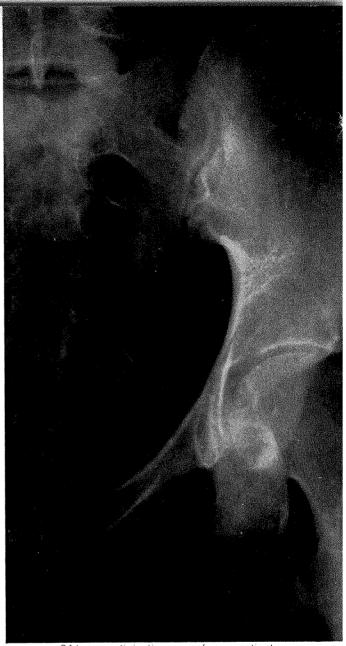
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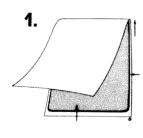
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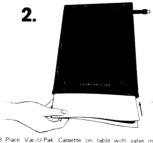
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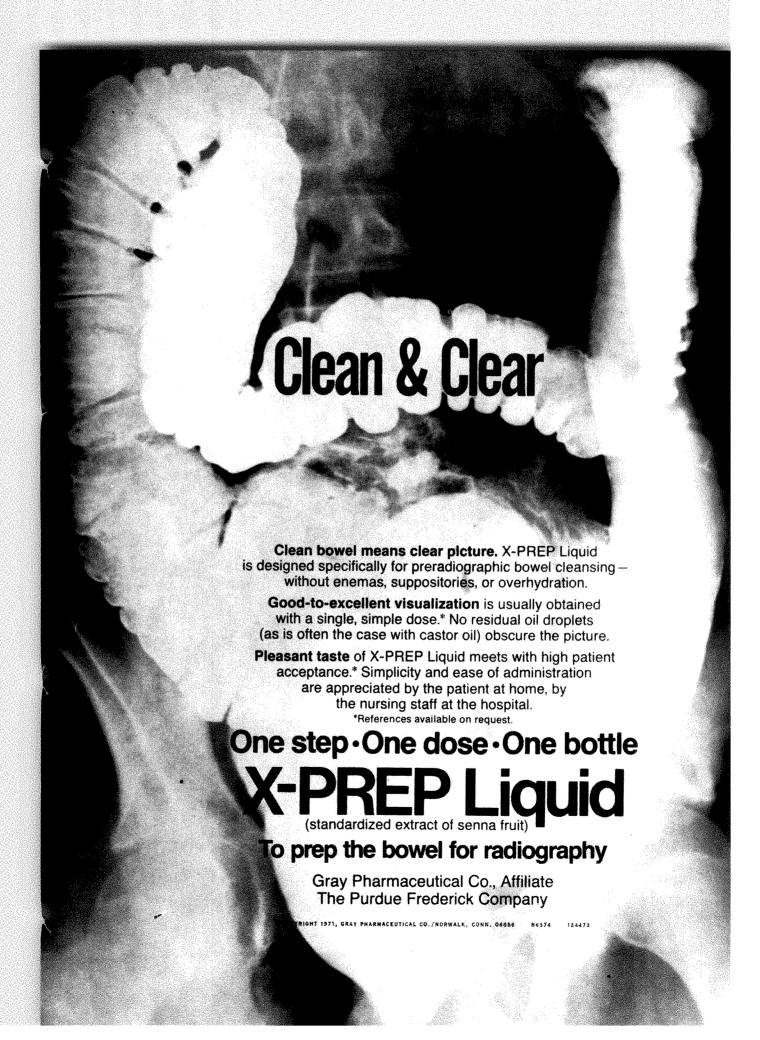
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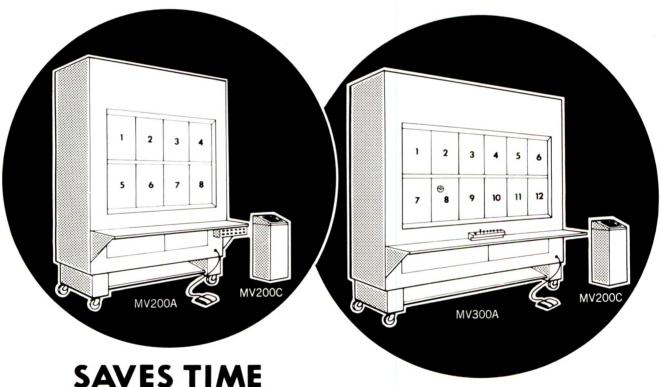
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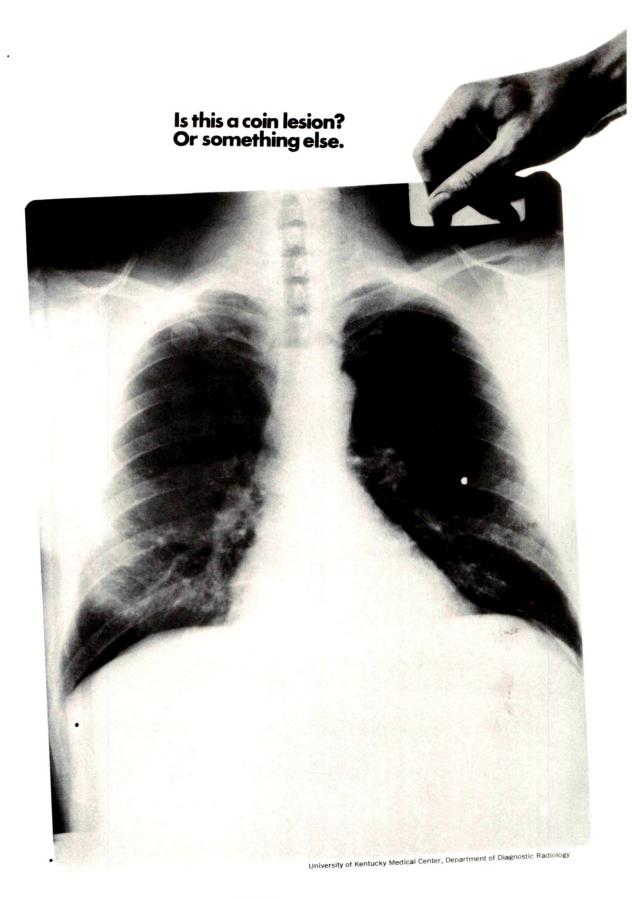
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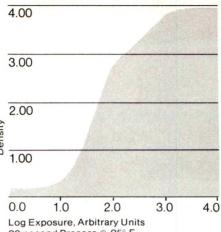


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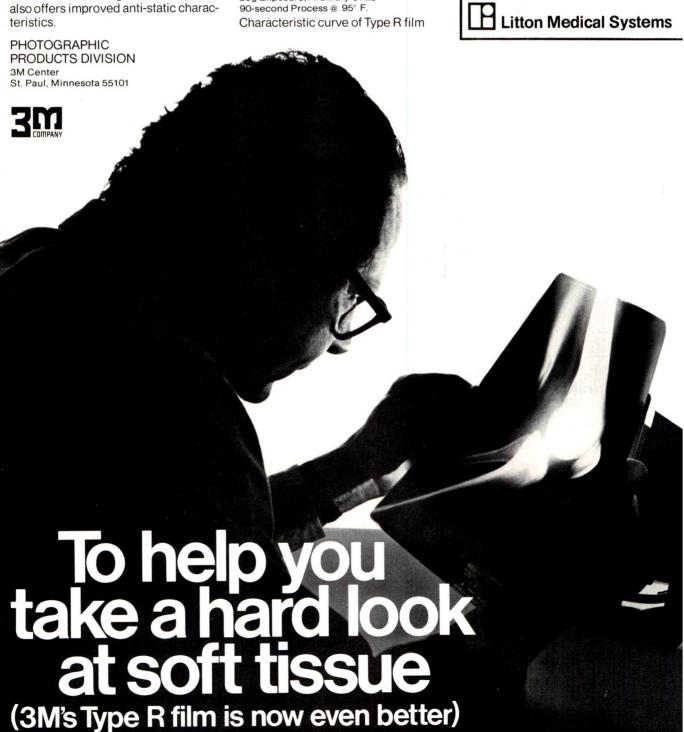


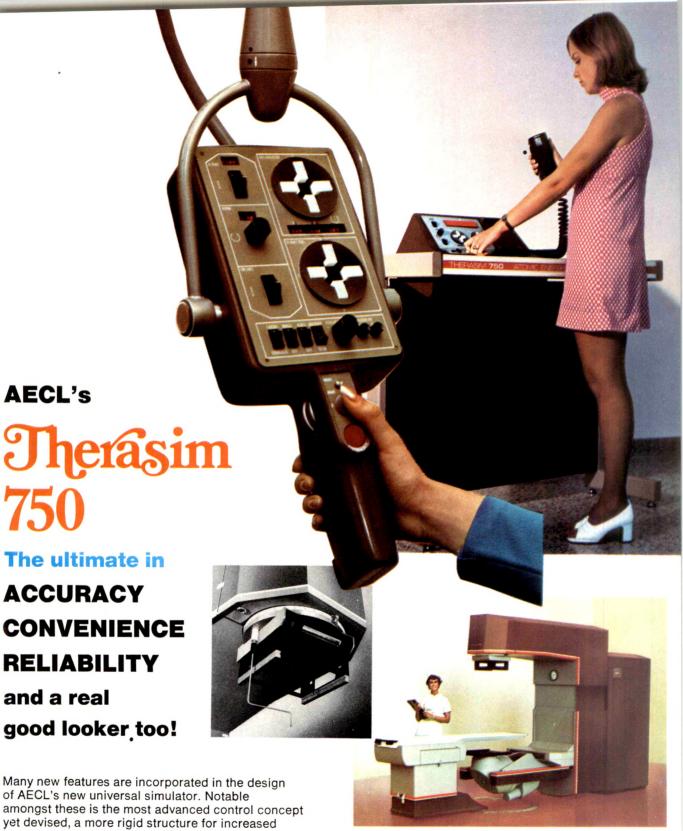
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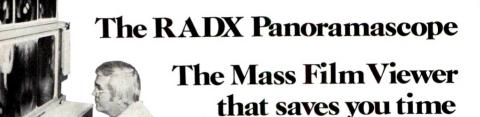
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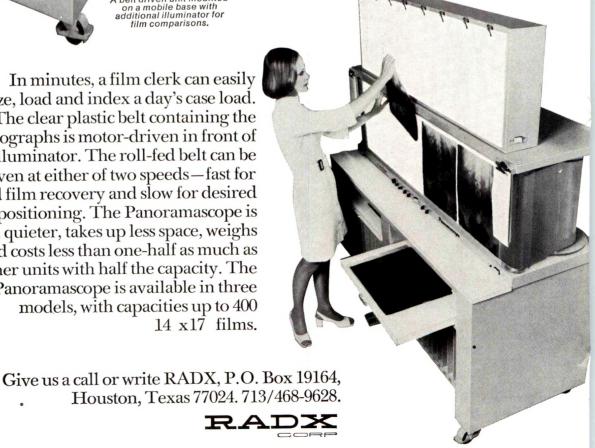
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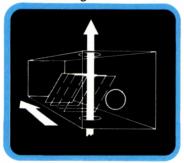
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# Something else.



What you see in the radiograph on page ix is just a coin placed on the patient's posterior right hemithorax. It does bear a resemblance to the coin lesion produced by a benign solitary lesion, perhaps a hamartoma or tuberculoma.

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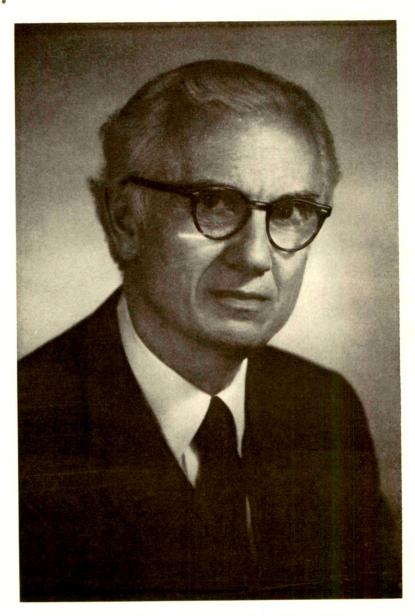
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MILFORD D. SCHULZ, M.D. JANEWAY LECTURER, 1974

# THE AMERICAN JOURNAL OF ROENTGENOLOGY RADIUM THERAPY AND NUCLEAR MEDICINE

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#### THE SUPERVOLTAGE STORY\*

JANEWAY LECTURE, 1974

By MILFORD D. SCHULZ, M.D.†
BOSTON, MASSACHUSETTS

WHEN your Janeway Lecture Committee calls upon one of the members of this Society to give the Janeway Lecture, it is in a way a command performance. I am immensely grateful to you all for the high honor of being asked to join the distinguished company of Janeway lecturers.

In casting about for a subject both instructive and entertaining, it occurred to me to try to take out of the night of yester-year the story of how the hardware of megavoltage, more vulgarly called super-voltage, x-ray therapy came to be. So for the rest of the hour, let us listen to Munin, our messenger of memory, who with Hugin, the messenger of thought, appear on the heraldry of this Society (Fig. 1). It is good, as I said to this Society now some 15 years ago, from time to time to recall the past beyond the memory of many of us so that we may know of how those things which we accept as commonplace came to be.<sup>110</sup>

In doing this, I pay respect to the physicists and engineers from whose ideas these tools have sprung and to the perceptive physicians who saw the potential of these

tools in improving the lot of our patients. It should here also be noted that with few exceptions these tools of Radiotherapy of which we will speak were the spin-off of the tools of the nuclear physicist. While creating these devices, it was often the perceptive physicist and engineer who, having developed this device, and who, through some experience or other recognized the potential usefulness of his brainchild in clinical medicine and biological research, sought out the physician and biologist and said in effect, "Here, I have something which may be of use to you."

In developing this narrative, time requires that we stick pretty much to the photon story and leave that of the development and use of devices for irradiation by energetic particles, as fascinating as it may be and as important a role as these devices will play in the Radiotherapy you will come to know, to some future Janeway lecturer.

TELECURIE THERAPY DEVICES

The first sources of supervoltage radia-

<sup>\*</sup> Presented at the Fifty-sixth Annual Meeting of the American Radium Society, Maui, Hawaii, April 21-25, 1974.

† Radiotherapist, Department of Radiation Medicine, Massachusetts General Hospital, and Professor of Radiation Therapy, Harvard Medical School, Boston, Massachusetts.



Fig. 1. Odin, Hugin and Munin.

tion were of course telegamma apparatuses using radium. Because of the limited supply and high cost of radium, these devices never did meet, especially in this country, with widespread use. They had even in their most sophisticated form all the physical disadvantages one could think of—but they did have one great advantage, that of beam quality, which clinicians were quick to recognize. The constraints of time force us, however, to pass by this most interesting period with but a nod of recognition, but I do want to look into a few doors as we hurry by.

The first man it seems who hit upon the idea of using radium in quantities at a distance was a Dr. König at the Women's Hospital in Breslau, who in 1912 built what he called a "radium cannon" for the treatment of pelvic cancer. He quickly aban-

doned this idea, however, because it tied up his entire supply of mesothorium. The development of this idea had to await the acquisition of radium in significant quantities.<sup>115</sup>

Probably the first apparatus for using radium in quantities at a distance from which gamma rays emerged in a beam and thus the beginning of what we may reasonably call megavoltage therapy was that built by Eric Lysholm<sup>(a)</sup> at the Radiumhemmet in Stockholm in 1922.<sup>88</sup> It contained 2 grams of radium at a distance of 6 cm. from the surface and offered some protection to both the patient and user. He called it a "radium howitzer." (a)

Dr. Burnham, (a) in his Janeway Lecture

<sup>(</sup>a) Portraits, communications and other illustrative material referred to and marked (a) are on deposit at the American College of Radiology Foundation Museum.

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before the twenty-first meeting of this Society, described the first use of radium in this country at distances up to 10 cm. for the treatment of deep-seated lesions as occurring in the fall of 1913 by Dr. Howard Kelly (a) at the Gynecologic Department of Johns Hopkins. He then, however, went on to say that the first crude attempts at constructing the true telegamma apparatus did not occur until about 1918, (a) and it was not for another 3 or 4 years that a proper fixed and supported apparatus was constructed for the purpose. 16,17

Radium in the early days was a rare commodity and tremendously expensive and consequently only very few places in this country and abroad were able to sequester 2 or more grams in a bomb. Therefore, until new sources of radium, principally American and Canadian, were found, the number of radium induced gamma ray beam devices remained few. C. W. Wilson, in his Presidential address to the British Institute of Radiology in 1959 reviewed 30 years of telecurie therapy experience and stated that until 1929 there were only 6 such devices in existence—I in Stockholm; I in Baltimore; I in Brussels; I in New York; and 2 in Paris. Perhaps he missed a few, but certainly he was not very far off. 162 There was in the 30s and 40s, especially in Britain and Sweden, a limited development of the use of radium as a beam source, but this story we must leave to some future review. 6,7,15,34,51,90,91,107,116,120,125,138,163 Radium telecurie therapy, like the Bach family, reached its ultimate degree of development in the closing days of its era with the greatest and also the last of all. This was the 50 gram bomb (a) which Dr. Failla (a) designed and built in the early 1950s for Dr. Douglas Quick, (a) past Janeway lecturers both, for installation at the Roosevelt Hospital in New York. (a) 112,113 It is appropriate that the clinic in which this installation took place is called the Janeway (a) Clinic after the man whose name has been chosen to represent those pioneering physicians and scientists to whom we, through these lectures, seek to do homage. This device, which had an output of 3 r per

minute at a depth of 10 cm., was reported to this Society at its 1954 meeting and soon after was decommissioned and with it an era in the history of Radiotherapy came to an end. This machine was already doomed to obsolescence at birth and with it, all lesser so-called radium bombs. The Cobalt 60 era had already dawned.

Dr. Henry Schmitz(a) in 1935, on the occasion of a symposium on radium packs held at the 20th Annual Meeting of this Society, was the bellwether of the next chapter in our story with a statement, the essence of which follows: "Radium cannons containing 4 grams of radium . . . require 30 hours to treat one patient. About 90,000 patients require some form of distant radiation (per year). . . . Therefore, since about 200 patients can be treated with a 4 gram cannon per year, about 3,000 cannons of 4 grams each of radium would be required. This means that 1,200 grams of radium at about \$50,000 per gram would have to be procured to enable the medical profession to treat all cancer patients adequately with radium at a cost of 60 million dollars.

"Modern installations for roentgen therapy, containing 1,000 kilovolt transformers can take care of one patient within 4 hours or about 750 patients per year. Hence, 120 roentgen stations would be necessary... at an average investment of 60 thousand dollars per station or a total of 7 and a half million dollars.

"The amount of radium needed is not available and probably never will be. Transformers can be built in quantity and could soon be supplied . . .

If each university hospital would create a radiation center for the state in which it is located, then adequate care of the cancer patient would be solved."138

This argument has its obvious defects, but nonetheless was, I believe, for its time remarkably perceptive.

#### TRANSFORMER JOBS

Largely as the result of the experience with telecurie therapy devices, it was generally recognized by the late 20s and early 30s that there were advantages to be gained

by the use of so-called "harder" radiations, and this of course led to the search for a means of producing x-rays at ever higher voltages. In 1928, C. C. Lauritsen (a) of the California Institute of Technology had developed a rig to produce x-rays at <sup>3</sup>/<sub>4</sub> million volts. 85-87 Dr. Albert Soiland (a) related that "during the summer of 1930 he was invited by Doctors R. A. Milliken and C. C. Lauritsen of the California Institute of Technology to inspect the high voltage tube installed at the Institute. It had occurred to Dr. Lauritsen that the radiation produced by this tube might have some biologic effect which could be utilized in the treatment of disease."131 Dr. Soiland was impressed. He promptly arranged to have patients brought to the Institute from his clinic in Los Angeles. The first patient, a man with inoperable carcinoma of the rectum, was treated in October of 1930. He was reported to be vastly improved and alive 2 years later. 131,133 This appears to have been the first medical use of x-rays in the submegavoltage range.

As a result of these early trials, W. W. Kellogg of cornflakes fame gave the money to establish the Kellogg Laboratories at Cal. Tech. (a) 181 W. W. was the brother of John Kellogg who ran the Battle Creek Sanatorium in Michigan where Dr. James Case (a) had installed the first radiotherapy hardware operating at 200 kilovolts and so had some familiarity with the possibilities

of what was going on.

From this laboratory, in the mid 30s, came many published clinical observations which were enormously influential in spreading the supervoltage gospel.<sup>28,101,102,132</sup> The apparatus at the Kellogg Laboratories was described as having a tube 30 feet long with an operating potential of one million volts but ordinarily was driven at \(^3\)4 of a million volts. It was enormous; could treat 4 patients at a time and delivered 20 r per minute at 70 cm. and cost \$50,000. The results achieved were said to compare favorably with those of a 4 gram radium bomb except that many more patients could be treated in a day. A notable comment rela-

tive to this installation which is still valid today was to the effect that "such formidable installations would be prohibitive for the average radiologist to consider and would be limited to those institutions with engineering and physical skills available and should be centralized." <sup>131</sup>

Indeed, in the next half decade following this pioneering effort, a number of such "formidable installations" did occur in several centers around the country and since these were all something of a pioneering effort, we can take a quick look at each of

them and their keepers.

In 1931, Dr. Failla at Memorial Hospital in New York, as a WPA project, 114 Dr. Quimby tells me, installed a 750,000 KV machine developed by Drs. Coolidge, (a) Dempster, and Tannis at the General Electric Company.27 This used the multisection cascade tube which Dr. Coolidge developed in 1928, and was activated by an induction coil with a mechanical interrupter. 25-27,35,144 This instrument was to become a monument of sorts in the history of Radiotherapy for, in addition to being used for clinical purposes, some 150 patients were treated on it between 1931 and 1934, it was the instrument on which Drs. Failla, (a) Quimby, Marinelli, Henshaw and others did their pioneering physical and biological investigations.33

In 1931, Dr. Traian Leucutia, (a) supported by Dr. Corrigan, (a) installed at the Harper Hospital in Detroit an apparatus made by the Kelley-Koett Company which employed the Lauritsen type tube (b) some 13 feet in length with a grounded target which was driven by an array of Crockroft Walton generators cascaded to develop 900 kilovolts. It was in use until 1956 and was the equipment on which Dr. Leucutia and his colleagues were to produce their fundamental observations which did much to establish clinical radiotherapy. (74–77)

There were two other so-called super-voltage outfits built and installed by the Kelley-Koett Corporation in the early 30s. One was installed, of all places, at the Lincoln General Hospital in Lincoln, Ne-

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braska in 1933 for Dr. Roscoe L. Smith (a) and T. R. Fulsom, (a) his physicist. This was advertised as a 1.24 million volt machine able to treat 4 patients at a time but did well to operate at 650 kilovolts and was apparently beset by many difficulties, and when I visited Lincoln in 1939 the building in which it was housed was gutted and the generator and tube were already taken down. 18,27,103

The other was installed at the Miller Hospital in St. Paul in 1936 for Dr. Schons. (a) The machine worked and the 30 foot long tube operated for years with the help of a great deal of Glyptol. (a) 4,18,46,47,66,100

There were two other devices which we may term protosupervoltage units, both of which were built by the General Electric Corporation. Both used tubes of the Coolidge cascade type and were driven by a cascaded array of transformers. 48-50,63,122-124, 145,146 The first was installed at Mercy Hospital in Chicago in 1933 by former Janeway lecturer, Dr. Henry Schmitz. (a)

The other was installed at the Swedish Hospital in Seattle in 1934 for Dr. C. B. Ward<sup>(a)</sup> and John Rose, <sup>(a)</sup> his physicist, <sup>145,152</sup> at the urging of Nels Johanson, a citizen of Seattle of Swedish extraction, after a visit to the Radiumhemmet in the early 30s. <sup>118,145,152,161</sup> This device is the one on which Drs. Simeon Cantril<sup>(a)</sup> and Franz Buschke, <sup>(a)</sup> past Janeway lecturers both, gathered the experience which resulted in many of their classical reports in Clinical Radiotherapy. <sup>19</sup>

All or most of these devices, pioneering as they were, could with careful coaxing be made to achieve a voltage of one megavolt but in practice all ran at something less. There was one other transformer driven machine of this genre which did run at a true megavolt and although it was not in the United States, it will be mentioned because it was also a milestone. This was put into operation in 1935 at St. Bartholomew's Hospital in London. (a) It ran all through World War II and was still doing yeoman service when I visited it in the mid 1950s,

although it is now gone. It was the basis of the slim and classical monograph by Ralph Phillips, who later became radiotherapist at Memorial Hospital in New York, and a respected member of this Society.<sup>109</sup>

While recalling these primitive, transformer driven, air insulated behemoths, we must also look at another different but related device for making megavoltage x-ray. Dr. David Sloan invented this generator, an ingenious, self-contained, and by 1930 standards, small machine driven by a power source which was in fact a radiofrequency transmitter operating at 6 megahertz. (a) 83,84,128,129,137 The first (a) Sloan type generator was constructed by Dr. Stanley Livingston and installed at the University of California Hospital in 1934 for Dr. Robert Stone. (a) 13 It operated at an honest one megavolt and was the basis of many clinical reports by Dr. Stone and others which over the years did much to forward the specialty.119

The other generator of the Sloan type was installed in the mid 30s at the Columbia-Presbyterian Hospital in New York for Dr. Francis Carter Wood. (a) He also was a Janeway lecturer. It was on this machine that Dr. Packard did much of his radiobiologic work. Its picture appeared in an article on Cancer Control in *Life* magazine (a) in 1937 and although it too, like all of these pioneering devices, became obsolete, its outer skeleton still remains and is used as a vacuum vessel in Dr. Rossi's Laboratory at Columbia. It is not the control of the second of th

At this point, we will digress for a few minutes and consider, for the sake of completeness, another good idea which, however, never caught on or did not work. This is the impulse generator with Marx<sup>(a)</sup> circuit, a condenser discharge apparatus which Dr. Coolidge thought had much promise.<sup>26</sup> In this apparatus, a battery of condensers was charged in parallel and then discharged through an x-ray tube in series. It was capable of developing voltages over 2,000,000 with massive currents. Its x-ray output was enormous, a single discharge was reported as producing enough x-rays to cause the death of a mouse. As far as I can find out,

however, nothing ever came of this idea as a radiotherapeutic tool, although it apparently did have some vogue for a time in nuclear circles.<sup>9</sup>

This now brings us to a more modern era of our story when survival of transformer driven machines meant reduction to manageable size, improvements in protection from both radiation and electrical hazards and development of flexibility which the precision of modern radiotherapy required. In this country, most of this development occurred at the General Electric Company by a team led by Drs. Charlton, (a) Hotaling, Westendorp, (a) and Dempster. 144,146 Around 1937, this team took a low frequency resonance transformer which they had previously developed, put a Coolidge cascaded tube axially through the center of the transformer and the whole into a tank in which insulation was provided by pressurized gas, Freon. 20-23,144 An apparatus of quite manageable size resulted. One such apparatus, operating at 1,000 kilovolts, was installed at the Memorial Hospital in late 1937:21 others followed.

Then it became only a matter of engineering to develop a sealed-off tube allowing the development of a fully mobile and flexible apparatus. Such a device was first described by Charleton and Westendorp in the early 40s and became the prototype of the machines working at one million volts, followed, soon after, by a self-contained, completely flexible rig operating at 2 megavolts. Both of these devices were widely used in industry and defense. Production for medical purposes began in 1946 and by 1958 Dr. Dale Trout counted 15 one megavolt and 9 two megavolt installations in such use.144 But progress continues and by present day standards even these are considered to be unnecessarily large and are now almost obsolete. The last transformer driven megavolt device for clinical radiotherapy in the USA was made by General Electric in 1963, by which time 16 two million volt units were installed and presumed to be in operation in the United States.<sup>52</sup> Some of these are still operating, but many have been dismantled and when

they are gone the chapter on transformer driven megavoltage x-ray therapy machines will be closed. (a)

#### VAN DE GRAAFF GENERATORS

We must now consider the last of the low megavoltage generators in which the x-ray beam was generated by an electron beam accelerated in an electrical field in which the potential differences were the same as the energies achieved. This is the so-called Van de Graaff electrostatic generator.

In 1932, when young Dr. Robert Van de Graaff (a) had been brought from Princeton to Massachusetts Institute of Technology by Dr. Carl Compton, most physicists and engineers had pretty much discarded electrostatics as a serious source of power. Dr. Van de Graaff had faith in the future of this form of high voltage generation and developed an electrostatic generator which was capable of developing voltages of up to 5 million volts. This generator is now part of the permanent technologic exhibit at the Museum of Science in Boston. (a) 117,143,149,150

Some time in 1932, Dr. George W. Holmes, (a) Radiologist, of the Massachusetts General Hospital, spoke at the Massachusetts Institute of Technology on "Some Clinical Aspects of X-radiation." Word filtered down and Dr. Van de Graaff and Dr. John Trump, (a) a young engineering research assistant, who was working with Dr. Van de Graaff on high voltage insulation problems, thought that they might have something which could be used for medical purposes. A meeting was arranged at the Massachusetts General Hospital not long thereafter to discuss these possibilities. Dr. Richard Dresser, (a) who was radiologist at the Collis P. Huntington Memorial Hospital in Boston, a hospital owned and operated by the Harvard University Cancer Commission, having heard of this meeting called on Dr. Trump in the spring of 1935 to ask if he thought Van de Graaff generators could power an x-ray tube at perhaps 400 kilovolts for therapeutic purposes. An entry from Dr. Trump's note1

book dated April 26, 1935 reads as follows: "Talked with Dr. Dresser and the electricians at the Huntington Hospital relative to x-ray generators. May be interested in building one if they can get the money."142 Dr. Trump's answer was, "Make it a million volts and we might be interested." One thing led to another and a trial was arranged using a 200 kilovolt x-ray tube provided by Dr. Dresser. (a) 139 A page from Dr. Trump's notebook dated May 25, 1935 showed the general scheme of things. 142 A high voltage discharge terminated the demonstration, but another more sophisticated demonstration was immediately planned using a more adequate discharge tube with a platinum Petri dish jury rigged as a target and a full-fledged demonstration took place on May 19, 1935. It turned out that the rig made x-rays, and lots of them, which were very penetrating. (a)

Everyone was convinced and the demonstration resulted in the construction at the Huntington Memorial Hospital, with the help of a grant of \$25,000 from the Godfrey M. Hyams Trust of Boston to Harvard University, of the first million volt Van de Graaff generator for radiotherapeutic and radiobiologic purposes.30 The first patient was treated on it on March 1, 1937. He was, as I recall, a dentist with carcinoma of the bladder who was alive in a nursing home when I, in 1941, reviewed the patients treated to that date. This machine was a magnificent monster, air insulated with a high voltage terminal some 10 feet on a side and large enough for a man to walk around in. The continuously evacuated tube was made of multiple porcelain sections 10 feet long to the focusing coil and extended through the floor of the generator room into the treatment room below, which as you can see had some thought given to the amenities. (a) 30 A fairly honest one megavolt was achieved by the use of 6 charging belts, each about a meter wide, driven by 3 electric motors at the rate of 4,000 feet per minute. The output was 40 r per minute at 80 cm. This was a truly wondrous machine, which a page from Dr. Trump's notebook shows cost—building and all—the magnificent sum of \$26,000<sup>(a)</sup> <sup>142</sup> (Fig. 2). This is the machine which first introduced me to Van de Graaff generators in December of 1939 and with which I have lived ever since. This machine operated, with the help of a great amount of Glyptol and with many battles with Boston's summer humidity, until late summer of 1941 when a strange illness beset it from which it recovered just in time to be running again gloriously when the Cancer Commission closed the hospital by the year's end. The original model of this machine now stands in the Countway Library in Boston.

By 1939, technology had advanced to the degree that a compact gas insulated generator operating at 1.2 million volts was installed at the Massachusetts General Hospital. The whole unit was contained in a flask which served as the pressure vessel fixed to the floor above the treatment room. The tube extended into the treatment room below, was continuously evacuated and had an output of 80 r per minute at 1 meter. It was dismantled after some 16 years of continuous service and is one of the few things the MGH ever threw away. (a)

At about the same time, a similar but trunion mounted generator was developed for installation by the Oncologic Hospital in Philadelphia. This machine has now been retired and forms part of an exhibit at the Smithsonian Institute. (a) 140,141

Early after the Second World War, improved engineering resulted in the development of a compact, flexible and reliable generator at the High Voltage Laboratories at Massachusetts Institute of Technology. This was to become the prototype of the machines for the manufacture and marketing of which High Voltage Engineering Corporation was formed by Drs. Van de Graaff and Trump, who were joined by Dr. Denis Robinson from the Fry group at the British Telecommunications Establishment. (a) 117,143

Not counting the prototypes made by the High Voltage Engineering Laboratories of M. I. T., 43 of these Van de Graaff gen-

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	Control panel	Instramente .	# 69	217.08	
	X-Ray Tube	15 Porcel sest.	# 225	440.74	
		5 Plywood rode	90	329.73	
	Pumping Section	Meel portion	#340	607.29	
		Gold.	#82	179.45	
	Cleet non gun			199.07	
	Lead Shielding			274.39	
	Tube Diaphrague Assoubly labor			217.61	
	Assaubly labor			3000.00	
	Voltage measurement	Splane gap.	#147.13		
		Aplans gap. Resistors	\$500	647.13	
	Mis cellansons			333.17	
		7.	tel.	\$12,024.65	
	Building returion		approx	14,000.00	

Fig. 2. Page from Dr. Trump's laboratory book showing the cost of the first Van de Graaff generator built for medical use.

erators which operated at 2 million volts were made for clinical use by the time the last one was installed in 1969. Of these, 35 were in cancer management centers in the United States. 55,117,143 These low megavoltage x-ray sources were truly milestones in the progress of Radiotherapy and the name "Van de Graaff" has become somewhat of a legend (Fig. 3). Many are still operating today and although Van de Graaff accelerators continue to be developed and used for a wide variety of other purposes, as an instrument for medical radiotherapy it is only a matter of time when they, with transformer driven low megavoltage machines, will have fallen to technologic progress and have gone to roost with the Dodo.

#### COBALT 60 AND OTHER SIMILAR TELEGAMMA SOURCES

Now comes that part of our story in which the instruments of modern radiotherapy, which form much of our present armamentarium, came into being.

The limitations of the radium bomb were strongly felt and when after World War II the fruits of the nuclear reactor became known, the idea that here now was the possibility of a radium substitute to satisfy the cry for more activity became apparent to a number of people.

Dr. Harold Johns (a) says that in the summer of 1946 he heard a lecture by Professor W. V. Mayneord (a) in which the possibility of using Cobalt 60 as a substitute for radium was discussed. 65,92 Marshall

Brucer (a) says that the idea of using Cobalt 60 in this manner was Grimmet's. (a) 10,11 Grimmet had been responsible for developing the so-called Bryant-Simmons teleradium unit which was to become more or less standard in England and over which he apparently was forever fretting about ways to improve its output. I. S. Mitchell (a) of Addenbrookes Hospital in Cambridge seems to have been the first, in 1945, to have written of this possibility. Is Just who first struck upon the idea will probably never be known for Brucer says, "It was in the air."

At first, the idea was to upgrade existing telecurie devices by replacing the radium with 10 or more curies of Cobalt 60 and this was actually done in Britain, (a) Sweden (a) and at least one place in the United States. (a) 78,80,108 However, the possibility of developing completely new devices using very large amounts of radioactive materials, 1,000 curies or more, and so developing telecurie units having geometry and output comparable to x-ray generators. soon too was in the air. Apparently, the first efforts in this direction were, in fact, at J. S. Mitchell's place in Cambridge where a telecurie irradiator using iridium 192 (a) was designed by Freundlich, (a) Haybittle and Quick and installed at Addenbrookes in May of 1950.38,54 The short, 74 day half life of iridium, however, made this device impractical. The obvious radium substitute was, of course, Cobalt 60 with its 5 year half life and 1.2 MeV gamma rays. The only drawback in the later 40s was that it was hard to come by. Cesium 137 had a suitably long half life, 30 years, and was plentiful, although with rather a low specific activity. It was seriously advocated by Brucer<sup>11</sup> and a few others<sup>54,155</sup> and did indeed have a brief flurry of popularity which culminated in the construction of a wonderful Rube Goldberg gadget at the Oak Ridge Institute of Nuclear Studies. (a) This was briefly put to work in 1955, but fortunately never caught on.12-14

The precise chronology of the development of the prototypes of the Cobalt 60 teletherapy devices we know today is a bit



Fig. 3. The name "Van de Graaff Generator" achieves the notoriety of being adopted by a Rock Group.

befogged by differences in how people remember things as they were. There were however 3 principal stages and sets of actors—I in the U.S.A. and 2 in Canada.

Grimmet had, in 1949, left Britain and joined the Physics Department of the M. D. Anderson Hospital in Houston.<sup>36</sup> Brucer states that Grimmet visited Oak Ridge on August, 22, 1949 and as a result of this meeting with Grimmet and Paul Aebersold, they developed first the idea and then the design (a) of a telecurie therapy source using a kilocurie of Cobalt 60, which in modified design (a) was to be built by the General Electric X-ray Corporation, under a contract let by the M. D. Anderson Hospital under the date of July 12, 1950.10,11,36 This was eventually fired by 1 of 3 kilocurie Cobalt 60 sources irradiated in the heavy water pile at Chalk River, Canada, irradiation of which was completed in the summer

of 1951. Gilbert Fletcher states that this device was not installed at the M. D. Anderson Hospital for clinical use until September of 1953, (a) but that from September of 1951 until then it was housed in temporary quarters where Jasper Richardson, a physicist from the M. D. Anderson Hospital, worked out basic physical problems. This unit is now decommissioned and forms part of the College of Radiology Museum. 36,50,146

Quite independently, and simultaneously, it seems that the idea was abroad in Canada. T. A. Watson, (a) Mayneord and Johns, after a number of meetings with the people of Atomic Energy Commission of Canada, were able, with the help of Dr. Cipriani, a radiobiologist working a Chalk River, to get the A.E.C.C. to consider irradiating a Cobalt 60 source which would have an activity of 1,000 curies. It turned out that 3 such sources were in fact placed in the heavy water pile, one for Drs. Watson (a) and Johns, who were at that time at the University of Saskatchewan in Saskatoon; another for Canadian Atomic Energy Commission to be noted later and the third which was planned for Mayneord but which eventually went to Oak Ridge for the purposes already described. 49,65,146,154 Harold Johns had in the meantime designed his version of the Cobalt 60 bomb (a) and had it manufactured by John McKay of the Acme Machine and Electric Co. of Saskatoon, so that it was ready to receive the source when irradiation was completed in the summer of 1951.64,89,154 This device (a) was installed at the Hospital of the University of Saskatchewan in August of 1951, and on it the first patient—a postoperative breast case—was treated on November 8, 1951. This unit (a) continued in operation with a modified collimator until 1972 when it was decommissioned and now rests in a museum in Saskatoon. 65,154 It was the prototype of over 100 similar units marketed over the ensuing years. Dr. Johns says that Dr. Allen Blaire, Director of Cancer Services for Saskatoon and who died before things really jelled, must be given credit for getting the money for the Saskatoon effort.

In the meantime, what was to become the prototype of the first commercially produced Cobalt 60 teletherapy unit (a) and known as El Dorado #I was built by the Commercial Products Division of the El Dorado Mining and Refining Co., Ltd. of Ottawa, later to become the Commercial Products Division of A.E.C.L. after designs by Greene and Errington. This machine received the third of the first 3 kilocurie sources irradiated at Chalk River. It was installed by the Ontario Cancer Foundation for Dr. Ivan Smith (a) at the Cancer Clinic in Victoria Hospital in London, Ontario, in October, 1951, and, as far as I can find out, the first patient ever treated by a kilocurie Cobalt source was treated there on October 27, 1951. This machine was in service until August 15, 1963 and is currently on display at the Museum of Science and Technology in Toronto. 5,31,48,49,63-65,95,154

Cobalt 60 telecurie therapy rapidly caught on and by 1961 there could be counted about 1,500 such units in the world, of which about 475 were in the United States and Canada and by 1968, according to the International Atomic Energy Agency report, this number had grown to 625 and by 1973 to over 1,100.31.62,147,148

In 1953, Braestrup described the basic isocentric design<sup>(a)</sup> for these devices which in some modification or other are now probably the work horses of modern radiotherapy centers throughout the world.<sup>8</sup> Whether or not their widespread appearance in every village and town is a good thing remains to be seen. One fact can be noted; to date they are alive and flourishing.

#### BETATRONS AND LINEAR ACCELERATORS

Now we come to the last stage of our journey and will take a brief look at the story of the development of the multimegavolt roentgen ray sources in common use today. Two to three MeV is about as high as one can go by impressing a simple volt-

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age difference on an electron and still have a practical machine from which you can get x-rays in the multimegavolt range. To go higher, one must resort to a sort of finesse in which electrons or other charged particles can be made to achieve energies higher than the actual voltages used—these are the particle accelerators which fall into 2 general classes; the orbital and straight line accelerators. Most of these were developed principally for investigations of the nuclear physicists but from which Medicine has benefited, albeit in a somewhat tangential fashion

For the purposes of our story, we will stick to those particle accelerators which can accelerate electrons to high energies and consequently make supervoltage x-rays—the betatrons and the so-called linear accelerators.

Everyone knows that Donald Kerst, (a) while at the University of Illinois, developed the betatron(a) in the period between 1938 and 1940. His first (a) betatron was a small piece of machinery which accelerated electrons to 2.3 MeV. Later, while working at the General Electric Co., more sophisticated models were built and by 1942 he had developed a large device which accelerated electrons to 20 million volts. At the University of Illinois, with a team of extraordinarily talented young physicists from which a veritable galaxy of stars developed, including Gail Adams, John Loughlin, Lester Skaggs, Howard Lanzl to mention but a few, he made a prototype of the machine which was to be manufactured and sold in this country by Allis-Chalmers (a) for many years—until only last fall in fact. 68-71 The exploitation of this idea in Europe is another story which we will have to skip today.66,158

Now we must go back a few years, for as is so often the case, the idea of the betatron did not come to Kerst *de novo*, but was, in essence, around a long time, as Kerst nicely tells in his Sigma Xi Lecture of 1946.<sup>68</sup> He was just the first man to make the idea work.

Credit for first having the idea of accelerating electrons by magnetic induction seems generally to be given to Joseph Slepian, <sup>68,127,159</sup> an electrical engineer working on transformers for Westinghouse Electric Company (Fig. 4). In 1922, he applied for a patent for an "x-ray tube" which looks surprisingly like a schematic of a betatron. <sup>127</sup> It did not work but our fellow member, Dr. Wideroe, <sup>(a)</sup> says that had Slepian been able to look 30 years or more into the future, he would have found the solution to his problem. <sup>159</sup>

The idea of accelerating electrons in an eddy current field apparently came independently to a young Norwegian, Rolf Wideroe, (a) while an engineering student at the Technical Institute in Karlsruhe. 159 The essence of this is shown on a page from his notebook dated 15 March, 1923 (a) 15,3,23 (Fig. 5). He called this a design for a ray transformer. The first published work on electron induction acceleration indeed appears to be Dr. Wideroe's doctoral dissertation presented (a) in 1927156 and published in 1928 while he was in Aachen. 157 There he worked on the theory of the betatron and, in fact, had designed an electron accelerator using this principle of orbital acceleration; however,160 as a number of others to follow, typical of which is a device patented by Steinbeck (a) in 1937, it did not work. 134

Dr. Kerst relates that, while he was a teaching assistant at the University of Wisconsin, he used to take part in teaching seminars in the Radiotherapy Department at the University of Wisconsin General Hospital and so came to know of the possibilities of x-rays in the treatment of disease.71 So, when he returned to Urbana and would go over to the Carle Clinic to read Dr. Cesare Gianturco's Radiology journals, he suggested that he too might have something in his betatron which would be useful in the treatment of disease.44 And so it was that Dr. Henry Quastler, a remarkable man, was introduced to the betatron(a) and began a series of classic radiobiologic and physical investigations which resulted in

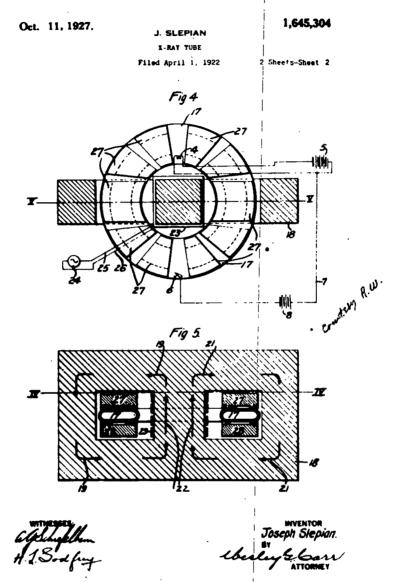


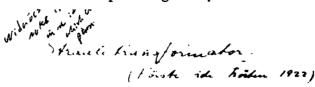
Fig. 4. U. S. Patent Application by J. Slepian for an "X-ray tube" dated 1922—courtesy of Dr. Wideroe.

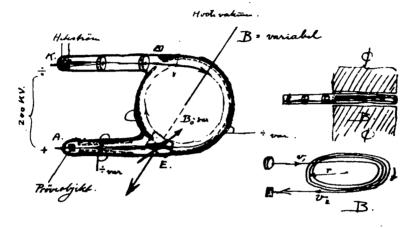
the treatment of the first patient with 22 MeV x-rays. This was on April 30, 1948. The patient was a young physicist with a brain tumor: so started multimegavoltage therapy.<sup>1,111,126</sup>

By the summer of 1948, a 24 million volt betatron was installed at the Physics Department of the University of Saskatchewan in Saskatoon. In March of 1949, Dr. T. A. Watson, Director of the Cancer Clinic in Saskatoon, after 9 months of intensive physical investigation by Harold

Johns and his team, began treating patients and thus started the really first concerted clinical investigation of the usefulness of multimegavoltage as a radiotherapeutic tool. 53,153

By 1951, when a 22 MeV betatron was installed at the University of Illinois Medical School in Chicago, 58,59,60,121 the betatron was an established tool in Medicine and by 1968, the International Atomic Energy Commission recorded that 27 betatrons were in operation in the United States; by





Straaletransformatoren blev uttantet for at skaffe tilstrakklig Koneentuste Energinningder til at sprenge Atomitigen For 4 aar siden vilde jeg opman dette vid at klume atomine saa tet sammen (med maganliote Felter),

Fig. 5. Page from Dr. Wideroe's laboratory notebook (in Norwegian) dated 1923 showing his early conception of a "radiation transformer"—courtesy of Dr. Wideroe.

1973 over 50 can be counted in this country and Canada.

#### LINEAR ACCELERATORS

Another method of getting particles to develop energies of many megavolts while actually exposing them to much lower voltages is by having them travel on a wave front. This is the linear accelerator, commonly called in today's slang, the LINAC, which is, as of today, the popular means of producing electrons and roentgen rays with energies in the 10, 20 and 30 megavoltage range with hardware of a size which is quite manageable in clinical practice.

The original idea of accelerating charged particles in a straight line to energy levels

higher than the actual voltages to which they were exposed seems to have been first described by a Swedish physicist, Gustav Issing, in 1924. He suggested exposing charged particles to a series of radiofrequency gaps. The first successful application of Issing's principle was again by our fellow member, Dr. Wideroe, who in 1926 accelerated potassium ions to energy levels of 50 kilovolts, while employing a maximum of 25 kilovolts. (a) 67, 81, 82, 157, 159

The interim development of this means of accelerating particles to exceedingly high levels, which proved to be useful in nuclear physics, lies outside our story, for it too, while it could be made to accelerate heavy ions and particles, could not, for relativistic reasons, accelerate electrons without the

use of "Extraordinarily long drift tubes or alternatively the use of radiofrequency sources of great power in the microwave spectrum" not available in the 30s, and consequently could not make megavoltage roentgen rays. This had to await technology developed during the Second World War, largely as the result of radar technology. 67,81

After the War, however, the appropriate technology was available and the idea of accelerating electrons to multimegavoltage energy levels using microwave techniques was taken up and developed quite independently, and apparently with little or no cross communication, by two quite separate groups—one led by M. Chadarow, (a) W. W. Hansen, (a) E. L. Ginzton, (a) and others<sup>24,45,46</sup> at the Microwave and High Energy Physics Laboratories at Stanford; and the other across the Atlantic at the British Telecommunications Research Establishment at Malvern and later at the Atomic Energy Research Establishment at Harwell, by a team headed by D. W. Fry, (a) and R. B. R. Shersbie-Harvie. 39,40,42,94,98,99, 104,105,117 This latter group apparently was indeed the first to develop after the War a practical resonance microwave electron accelerator in November, 1946. The Stanford group was not far behind.

The usefulness of this new means of getting a great amount of megavoltage x-ray for medical purposes was quickly realized and by 1949 the radiotherapeutic research unit of the Medical Research Council in Britain at the instance of Constance Wood, (a) L. H. Gray, (a) and P. Howard-Flanders was collaborating with the Ministry of Supply, with the Metropolitan Vickers Co., Ltd. and with General Electric of Britain for a linear accelerator for medical use to be built according to the design of Dr. Fry. The first microwave linear accelerator for medical use was installed at the Radiation Research Center of the Medical Research Council at the Hammersmith Hospital in London during 1952. (a) It was an 8 million volt machine with a fixed tube extending over a movable

floor. Therapeutic trials were begun in August of 1953. 93,106,164,167

While linear accelerators of isocentrically mounted design by Howard Flanders (a) were being installed in a number of cancer centers in Britain,56,57 there were no such instruments for medical use in the United States, although a number had been developed by the Stanford and M.I.T. groups for physical investigation.29,43 The first such proposal was apparently by Dr. Henry Kaplan of Stanford, who met with Dr. Ginzton in 1952 to discuss the practicality of building a microwave linear accelerator for medical use and developed an application to the American Cancer Society and the United States Public Health Service for support of such a project in that year.73

The first linear accelerator for medical use in the Western Hemisphere was accordingly built at Stanford University in 1954 and installed in 1955, (a) at the Stanford Hospital, then in San Francisco, and patient treatments were started in January of 1956. This machine was unique in that it was self-contained; had a sealed-off acceleration tube: was contained in a flask mounted on a flexible hoist supplied by the High Voltage Engineering Corp. of Cambridge, Mass., which is probably why it looked like the Van de Graaff generators of that era, and operated at 5 million volts. It was the basis of many reports issued from Stanford over the subsequent years and continued in service until 1972 when it was dismantled and given to the Smithsonian Institute in Washington. 45,47,72,73

In no time at all, the prediction that "as a means of generating high intensity x-rays of energy 4 to 15 million electron volts, we have no doubt that the linear accelerator is the machine of choice" rapidly was verified and to a degree scarcely less than the Cobalt 60 bomb. It quickly caught on and by 1968 there were 35 medical linear accelerators to be counted in the United States and Canada. By 1973, over 250 had been installed in the United States.

Until something new comes along-

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microtrons perhaps—it seems most likely that linear accelerators will be the principal sources of multimegavolt x-rays, although perhaps sharing the stage in the 20–40 megavolt range with betatrons, especially as sources of energetic electrons, serious work with which is just now beginning.

#### THE SYNCHROTRON

We must now, before the end of our saga, take a look at what, up to the present date, has been the last of the multimegavoltage devices used for medical radiotherapy. This is the synchrotron (a) which in one of its several forms is the present love of the nuclear physicist and can be made to accelerate electrons in the multimegavoltage range while still retaining acceptable, although just barely acceptable, physical size. 89,151

D. W. Fry (a) of the British Nuclear Energy Establishment suggested in the late 40s that this principle could be used for the generation of x-rays in the 10 to 15 megavolt range for medical purposes and still keep the hardware within manageable size.<sup>141</sup> The first such use of the principle was in the construction of a 30 MeV accelerator at the Radiotherapeutic Department of Addenbrookes Hospital in Cambridge for J. S. Mitchell in 1949.97 There was a second 30 MeV device installed in Britain. The only one installed in the United States was a machine secured by Dr. Robert Stone—Dr. Stone seems to have had a talent for doing things first—at the University of California in San Francisco in August of 1951. (a) This was a 70 million volt machine built by General Electric under contract with the Atomic Energy Commission, which supplied the funds for its operation as a program of clinical investigation and which Dr. Gail Adams states started clinical operations in July of 1955 and continued until July of 1963 when Dr. Stone retired. The use of this device for medical purposes was in the nature of a clinical trial and formed the basis of several reports• by Drs. Stone and Adams in 1964.2,3,136

It is an example of a once only effort and considering that it was a 70 million volt device, its size might be considered modest, but it was in fact just too unwieldy and 70 million volt x-rays are probably too much; it also has passed into history as a medical tool.

And now we have finished our somewhat hurried tour into yesteryear. We have had a few glimpses of how it was in our beginnings and have met some of the principals in the action; how to a degree it still is; but certainly not how it ever shall be—the microtrons and particles are coming.

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# INTERSTITIAL THERAPY USING NON-ABSORBABLE (Ir<sup>192</sup> NYLON RIBBON) AND ABSORBABLE (I<sup>125</sup> "VICRYL") SUTURING TECHNIQUES\*

By W. P. SCOTT, M.D. CHARLOTTE, NORTH CAROLINA

NTERSTITIAL irradiation therapy can be carried out simply and rapidly with the use of nylon ribbon† containing seeds of Ir192. In the past 13 years, I have had favorable experience with this method in respect to patient tolerance, tissue response, and tumor control. The method is versatile and effective, and more rapid and simple than afterloading ribbons into needles or tubing inserted into the lesion. Although the necessity of removing the nylon ribbon is a disadvantage, there are instances where it is not advisable to permanently leave the implanted seeds, such as in ocular lesions. The suturing technique is particularly successful in tumors in problem sites, for example, in awkward locations such as the nasopharynx, in recurrences in heavily irradiated tissue as in the head and neck, in areas requiring cautious placement, as the anterior vaginal wall, and in easily approachable areas, such as lymph nodes, which make up the bulk of our cases. In situations where a permanent implant is preferred or where removal of the suture would be difficult or impossible, the choice is an absorbable suture containing radioactive sources for permanent implantation. Earlier, I described<sup>2,3</sup> a method using I<sup>125</sup> seeds in an absorbable spacer made of surgical gut, and more recently an improved technique using I125 seeds segmentally loaded in an absorbable polyglactin (Vicryl) suture 1 on an atraumatic needle.

#### REMOVABLE IMPLANTS

Nylon ribbon with Ir<sup>192</sup> seeds spaced

† Ir<sup>192</sup> Nylon Ribbon: Howard Hospital Supply Corp., Washington, D.C. ‡ I<sup>125</sup> "Vicryl" Suture: Lawrence Soft Ray Corp., Mountain either 0.5 or 1.0 cm. apart and a needle of proper curvature and size to accommodate the anatomic situation are used, and I use small hemoclips rather than the large buttons supplied with a kit to secure the ends of the ribbon.

Surface lesions. Single plane implants are easily managed with a simple suturing technique. I first sutured Ir<sup>192</sup> in nylon ribbon into a squamous cell carcinoma arising in a pterygium in 1962. Figure 1A illustrates the pattern of placement of a ribbon in a conjunctival lesion where the optimal spacing of seeds would be 0.5 cm. apart. The Paterson and Parker chart for surface applicators, or for plane implants if indicated, is used to calculate the dosage. Figure 1B is a localization film of our first patient. Even with the ribbon implanted in this sensitive structure, it was well tolerated by the tissues with satisfactory healing.

Easily accessible superficial lesions. The easiest and most rapid implantations occur with continuous suture technique used in an external lesion such as a cervical lymph node. The ribbon can be passed through and around the tumor in a matter of seconds. If more than 12 seeds in one ribbon are needed, either two ribbons may be spliced with a single hemoclip or the two may be stabilized separately, each with 2 hemoclips. Figure 2A illustrates suturing patterns in small and large tumors. This outlines schematically a simple effective means of covering the tumor volume with ribbons which can still be removed without undue difficulty. The Quimby Data for Volume Implants are used for calculating dosage for this and the following types of permanent implants. Figure 2B is a localization film of three Ir192 nylon ribbons

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\* From the Charlotte Memorial Hospital, Charlotte, North Carolina.

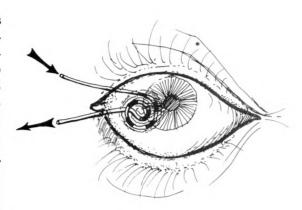
sutured in left cervical lymph nodes; the ends are secured with hemoclips.

3. Fairly accessible deep lesions. In this method, somewhat similar to the conventional afterloading parallel needle technique,1 the ribbons are placed parallel to one another with the ends uncrossed, unless a loop is made. This type of implant lends itself to the easiest and quickest removal by cutting one hemoclip and retracting the suture along with the other hemoclip. Figure 3A illustrates a convenient method of implantation in a deep but accessible tumor volume. Here large curved (1822-2) retention needles are first inserted parallel to one another 1.0 cm. apart, threaded with Ir192 nylon ribbon, and quickly pulled through. The hemoclip limits the advance of the suture at point of entry, and at the point of exit it is cut and secured with another hemoclip unless looped back via an inverted needle. Without looping, radiation at the ends can be augmented by either adjusting the hemoclip so that the seed is flush with the tumor surface or projects a little beyond it. The localization film, Figure 3B, shows a looped Ir192 nylon ribbon in a left vulvo-vaginal lesion which responded extremely well.

4. Poorly accessible lesions. One can hardly think of a more inaccessible site to implant than the nasopharynx, and Figure 4A depicts an approach to this problem. The ribbon is passed via the oropharynx into the tumor and out through the nose. The ribbon then is pulled forward as far as the hemoclip will allow and is secured externally. The ribbon is easily removed via the oropharynx by freeing the external end and retracting the internal end proximal to the hemoclip. In such situations, looping is difficult, but if necessary, the radiation at the ends can be increased as previously described. Figure 4B shows Ir192 nylon ribbons implanted and very well tolerated in a recurrent nasopharyngeal squamous cell carcinoma.

#### PERMANENT IMPLANTS

There are many more instances where it





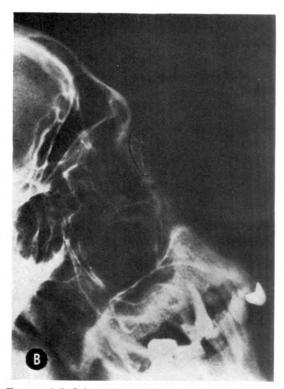


Fig. 1. (A) Schematic drawing showing placement in a surface lesion of the conjunctiva of a suture containing radioactive sealed sources. (B) Roentgen-ray localization of a single Ir<sup>192</sup> nylon ribbon implanted within a squamous cell carcinoma of the right eye.

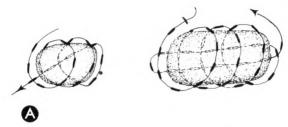




Fig. 2. (A) Schematic drawing showing a simple and effective continuous suture pattern to cover small and large tumor volumes with a suture (ribbon) containing radioactive sealed sources. (B) Roentgen-ray localization showing three Ir<sup>192</sup> nylon ribbons sutured in a left cervical lymph node. The ends are secured with hemoclips.

is preferable to leave the implanted seeds in permanently, as in lesions in the lung. I125 seeds loaded in a Vicryl suture on an atraumatic needle (Fig. 5A) are used. For implanting a tumor of 2.5 to 4.0 cm. in average dimension, the sutures are each loaded with 5 seeds, but for larger tumors sutures are loaded with 10 to 25 seeds each. The technique of choice for a permanent implant is the use of one long continuous suture made up of the combined active lengths of shorter sutures. If there is a possibility that the polyglactin absorbable suture might be later removed, the ends can be tagged with hemoclips rather than tied and buried. The I125 seeds are generally calibrated for 0.5 to 1.0 millicurie and set I.o cm. apart in a suture, measured from

mid-point to mid-point. Seeds are loaded closer together when low in activity or when needed to fit certain anatomic situations such as very small lesions. Rapid calculation for the required number of seeds in millicuries is easily determined by multiplying the average value of the 3 tumor diameters by an empiric factor of 5. The ease of suturing with a curved needle in and around anatomic corners is obvious. Speed

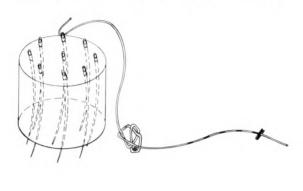




FIG. 3. (A) Schematic drawing of an interrupted suture technique for a volume implant using large parallel surgical needles. Alternate needles can be inverted in order to loop the ribbons. (B) Roentgenray localization of Ir<sup>192</sup> nylon ribbons sutured in a left vulvo-vaginal carcinoma. Buttons are now replaced by hemoclips.

and distance offer the best defense in handling radioactive sources and compensate for the time consumed with the various afterloading techniques. The exposure involved in removing radioactive sources is, of course, eliminated with the permanent implant. Figure 5B shows  $I^{125}$ 

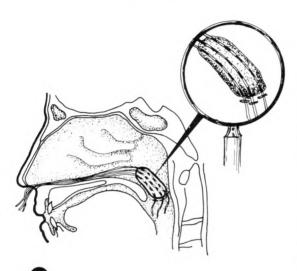




Fig. 4. (A) Schematic drawing of an approach to a nasopharyngeal lesion. Ir<sup>192</sup> nylon ribbons are passed via the oropharynx into the tumor and out through the nose. Removal is easily accomplished by withdrawing the ribbons through the oropharynx. (B) Roentgen-ray localization of Ir<sup>192</sup> nylon ribbons in a (right) nasopharyngeal tumor.



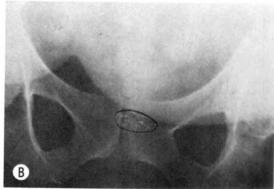


Fig. 5. (A) A sketch of a polyglactin (Vicryl) atraumatic suture loaded with twenty-five I<sup>125</sup> seeds for permanent implant. (B) Roentgen-ray localization of an I<sup>125</sup> Vicryl suture in a metastatic vaginal adenocarcinoma.

Vicryl sutures implanted in the left vaginal wall for metastatic adenocarcinoma reduced in volume following telecobalt 60 therapy.

#### SUMMARY

Permanent and removable interstitial implantation techniques using absorbable and unabsorbable sutures are described. Most of these techniques can be performed in the clinic easily and quickly with basic instruments: needle holder, needle book, and hemoclips. Specifically, Ir<sup>192</sup> (74.4 day half life, 300–610 keV, and 6.0 cm. hvl in tissue) nylon ribbon and I<sup>125</sup> (60 day half life, 27–35 keV, and 2.0 cm. hvl in tissue) Vicryl sutures are described. A major advantage of the I<sup>125</sup> over the Ir<sup>192</sup> seed (other than the fact that it can be permanently implanted and needs less radiation protec-

tion) is that the patient does not remain highly radioactive for as long a period due to the extremely low I<sup>125</sup> energy and may be allowed to leave the hospital. Both nuclides have the advantage of a long shelf life, making their use practical and economically feasible.

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### ANGIOGRAPHY OF RETROPERITONEAL TUMORS\*

#### A REVIEW

By B. DAMASCELLI,† R. MUSUMECI,† M. BOTTURI,‡ R. PETRILLO,† and I. SPAGNOLI†

THE clinical discussion of retroperitoneal tumors should be confined to tumors of mesodermal, neural, lymphatic and embryonal origin. To narrow the definition still further, we are excluding lymph node metastases from known primary tumors and iliac and lumbo-aortic lymph idenopathies associated with systemic lymphopathies. According to this justifiably strict definition, primary retroperitoneal tumors are a fairly rare clinical finding, and in such cases over-hasty recourse to exploratory laparotomy is all too frequent.

The impression gained from the literature is that angiographic demonstration of a truly primary retroperitoneal tumor, when not actually incidental, has emerged from retrospective analysis.<sup>2,5,8</sup> Our aim, therefore, is a critical appraisal, with the aid of some illustrative examples, of a consecutive series in which angiography was used systematically as the diagnostic procedure of choice for retroperitoneal tumors.

#### ANGIOGRAPHY OF THE RETRO-PERITONEAL SPACE

The retroperitoneal circulation is really an anastomotic network into which all branches of the abdominal aorta may flow. For this reason a vascular study must be individualized by preliminary reconnaissance with high quality aortography. For this purpose we recommend: percutaneous access from the femoral artery; injection above the 12th thoracic vertebra; injection rate at least 25–30 ml./sec.; adequate quantity of contrast medium; prone position in all cases; and a catheter of small external diameter. For selective angiography we would add: a preference for local anesthesia; lateral fluoroscopic control;

low-strength contrast medium; occlusive catheterization for the lumbar and intercostal arteries; and slow automatic injection.

Intravascular manipulation may be prolonged and the right choice of material is essential. Catheters should not be too stiff and should be blunt tipped to avoid intimal abrasion. Several spare catheters, differing in size of curve and flexibility, with or without side holes, must be at hand. The total quantity of contrast medium injected must be accurately recorded and the operator must be constantly informed. We think that it is wise to stop the investigation, resuming if necessary some days later, when a patient with good renal function has received 300 ml. of contrast medium. Catheterization of the lumbar and intercostal arteries may be difficult and may be helped by lateral fluoroscopic control. For this reason it is highly advantageous for the patient to be conscious so that he can relate his sensations on test perfusion of both sides. Simultaneous fluoroscopy in both projections is an asset. Contrast medium intake and radiation exposure could be reduced by intelligent use of a magnetic recorder, which gives the operator a chance to note transient test injections on small vessels.

#### MATERIAL AND RESULTS

Forty-five patients, 20 female and 25 male, aged between 3 and 65 years, with an abdominal mass suspected of being retroperitoneal, were investigated consecutively by angiography (Fig. 1, A and B; and 2, A and B). In 7 cases exploratory laparotomy with biopsy had already been done elsewhere; in these cases angiography was expected to determine if the mass was

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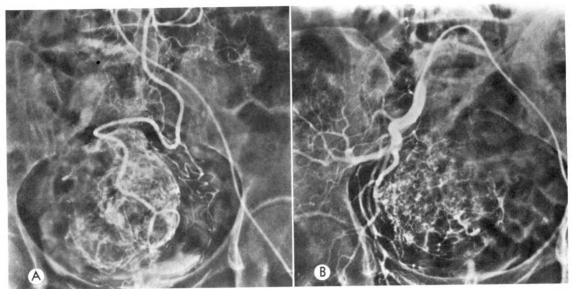


Fig. 1. (A) Hemangiopericytoma of the pelvic inlet. Angiography of the inferior mesenteric artery. This artery affords a good blood supply to the tumor except on the right side, where the poor supply suggests the participation of another vessel. (B) Angiography of the right internal iliac artery in the same case. The scale and type of the highly malignant blood supply are clearly identified.

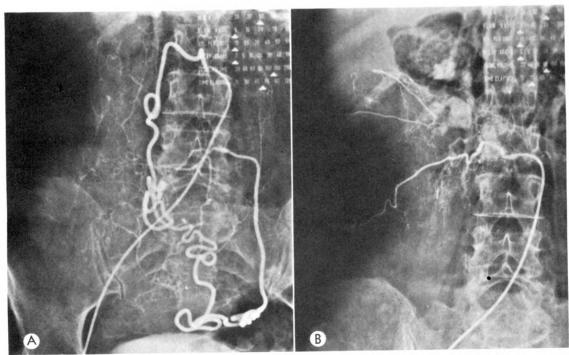


Fig. 2. (A) Retroperitoneal lipoma. Angiography of the right ovarian artery. This vessel is larger than is usually seen and its subsequent distribution was held to be neoplastic because of the variations of caliber in the finest arterial branches and because the contrast medium filled numerous lacunae at tumor level. (B) Lumbar angiography in the same case. The upper limit of the tumor is well defined.

operable or to define a possible irradiation field. The 5 cases of metastatic tumor included 3 cases of retroperitoneal metastases from teratocarcinoma of the testis in which the primary tumor was not identified (Fig. 3), and 2 cases of retroperitoneal lymph node metastases from seminoma of an undescended testis. In I case angiography demonstrated the primary tumor also.

Table 1 shows the angiographic assessment verified by the surgical findings. In 12 cases simple aortography supplied all the diagnostic information required. In all cases preliminary aortography was completed by selective angiography of one or more presumed major feeding arteries (Fig. 4). The diagnostic value, considering the high cost in manpower and resources and the hazards of angiography, was assessed strictly. Angiography was expected to establish the site, extent, nature—benign or malignant—and the involvement of neighboring organs (Fig. 5, A and B). The error rate was

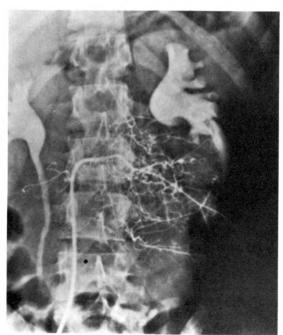


Fig. 3. Retroperitoneal metastases from testicular teratocarcinoma. The primary tumor was not found. Lumbar angiography correctly identified the site and extent of this tumor, which markedly deformed the lower pole of the left kidney and the ureter.

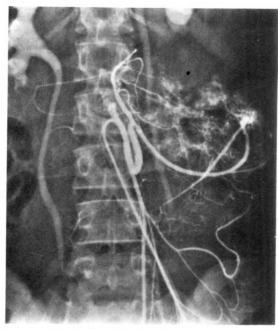


Fig. 4. Retroperitoneal rhabdomyosarcoma on the left side. Preliminary abdominal aortography had shown that the main blood supply came from the inferior mesenteric artery. Note the increased diameter of the arteries leaving this vessel for the retroperitoneal space.

estimated by adding the false and inconclusive information on any one of the above counts when checked against the surgical or histologic verdict. Four benign tumors were operated on successfully. Macroscopic radical removal was achieved in 11 malignant tumors. Two neuroblastomas, 2 liposarcomas and 1 rhabdomyosarcoma were partially removed.

Table II shows the relative frequency of the classic angiographic features by histiotype. The second part of the Table gives the frequency with which the various arteries acted as chief feeding artery to the retroperitoneal tumor. No noteworthy complication followed intravascular manipulation in the cases of this study and the reproducibility of selective catheterization was 100 per cent because every case presented with more than one arterial pedicle suitable for angiographic investigation.

DISCUSSION AND CONCLUSIONS
Retroperitoneal tumors, nearly always

 $\textbf{Table I} \\ \textbf{angiographic assessment of 45 histologically proved retroperitoneal tumors}$ 

	NT-	Adequately Visualized by Status of Angiographic Findings					
Histological Diagnosis	No. of Cases	Aortog- raphy	Additional Selective Angiography	Correct	Incor- rect	Incon- clusive	Error (Per cent)
Metastatic Neoplasm Chondrosarcoma Adenocarcinoma Hemangiopericytoma Malignant Histiocytoma	5 1 1 1	++	+++ + + + +	+++++			
Mesothelioma Malignant Lymphoma Undifferentiated Sarcoma Lipoma	1 4 2 1	· +	+ +++ ++ +	+ ++ ++	+ +	++	- Anna
Liposarcoma Leiomyosarcoma Fibrosarcoma Rhabdomyosarcoma	6 5 6 2	++ ++ +	++++	++++ ++++ ++++ ++		+ +	
Malignant Teratoma Hamartoma Paraganglioma Extra-adrenal Neuroblastoma Ganglioneuroblastoma	1 1 2 3 1	+++	+ + ++ +	*+ ++ ++	+	+	A STATE OF THE STA
Ganglioneuroma	<u> </u>		+	+	A		
Total	45	12	33	36	4	5	20

malignant, are insidious in onset, are difficult to approach surgically, tend to recur, and respond poorly to radiation therapy and chemotherapy. In these circumstances the chances of cure at first attempt depend on accurate preliminary diagnosis, usually roentgenologic or by laparoscopy with biopsy. Of the usual roentgenologic procedures (urography, retropneumoperitoneography, lymphography, inferior cavography and angiography), only angiography ranks as a direct method for diagnosing the site and nature of an abdominal spaceoccupying lesion. The results of systematic angiography in 45 primary retroperitoneal tumors are as follows.

In 73 per cent of cases abdominal aortography had to be supplemented by selective angiography to reach the reasonable level of confidence in the diagnosis, which is possible only by demonstration of the feeding arteries of the tumor (Fig. 6). Nearly all

the tumors were large masses with multiple afferent vessels, some of which were compressed. A globally increased blood supply was observed in tumors "balling" towards the abdomen, and this was less so in tumors developing mainly in the vertebral grooves. This difference explains why the arteries were significantly enlarged in only half the cases, mostly in tumors supplied by the large arteries of the digestive tract and the renal arteries. In many of these patients the diagnosis of site was made by filling the lumbar arteries, of borderline normal caliber, in the preliminary aortography.

A pathologic distribution of the lumbar arteries was by far the most frequent finding (48 per cent of cases) and catheterization of these vessels, as other workers have found, 4,6,7 seems to constitute an important stage in establishing the retroperitoneal site of an abdominal mass.

The wide variety of cell type made it im-

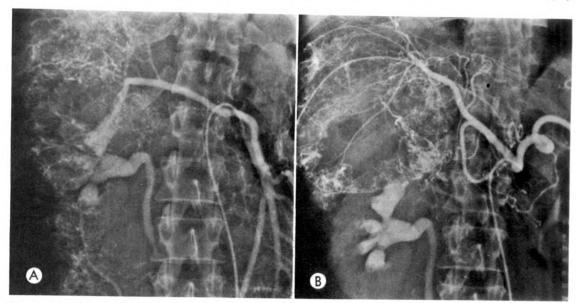


Fig. 5. (A) Retroperitoneal mesothelioma. A gigantic tumor occupies the right half of the abdomen and its blood supply is clearly demonstrated by the opacification of the upper mesenteric artery. (B) Celiac angiography shows invasion of the liver.

possible to correlate specific angiographic patterns with tumor types. As happens with soft tissue tumors of the limbs, all the roentgenologic characteristics of malignancy may be found in benign tumors and vice versa. The 20 per cent failure rate was due, in 4 cases, to mistaking the nature, benign or malignant, of the mass and in 5

cases to inconclusive information on the real extent of the tumor, which at operation was found to be infiltrating vital organs. The greatest difficulties in the roent-genologic diagnosis arose in poorly vascularized malignant lymphomas and in neural tumors. Of the latter, I extra-adrenal neuroblastoma was identified only indirectly

Table II

ROENTGENOGRAPHIC SIGNS FOUND ON ANGIOGRAPHY OF 45 RETROPERITONEAL MASSES

Disease No. o		0+-		Tumor Stain	Feeding Arteries						
	Cases	Vessels			Digestive	Phrenic	Adrenal	Intercostal	Lumbar	Spermatic	Renal
Metastatic Neoplasm	5	++	+++++	+++++	++				+++		++
Chondrosarcoma	1		+	+					1 1 1		7.7
Adenocarcinoma	I	+	+	1 +			+		1		
Hemiangiopericytoma	1	+	+	+	+				1		
Malignant Histiocytoma	I	+	+	+				+			
Mesothelioma	I	+	+	+	+				1		1
Malignant Lymphoma	4	+	++	++					++++		- 1
Undifferentiated Sarcoma	2	+	++	++	+				++		
Lipoma	1	+	+	+					1	+	
Liposarcoma	6	+++	+++++	+++++	+			++	++++	,	
Leiomyosarcoma	5	++	++++	++++	+			+	+++		+
Fibrosarcoma	6	+	+++++	+++++	+++				+++++		1
Rhabdomyosarcoma	2	++	++	++	+				++		1
Malignant Teratoma	I		+	+	+				1.1		
Hamartoma	1	+		+	+				+		
Paraganglioma	2	++		++		+		+	+		
Extra-adrenal Neuro-											
blastoma	3	++	++	++	++				++		
Ganglioneuroblastoma	1	+	100	+				+	+		+
Ganglioneuroma	I	+		+	+	+		+	+		,
Total .	45	24	34	30	16	2	I	7	35	I	10



Fig. 6. Retroperitoneal fibrosarcoma. Angiography of an intercostal artery, catheterized on the evidence of the preliminary aortography, shows the malignant blood supply above the left hip.

by extrinsic changes in the vessels.

These failures do not affect our final verdict on retroperitoneal angiography, which is definitely favorable. Although in a few cases the information was incomplete or inconclusive, in no case did retroperitoneal angiography prove to be useless or illadvised. In fact, direct visualization of the tumor or good topographic information, especially on connections with vital organs, such as kidneys and liver, was definitely illuminating for the surgeon and improved the general surgical management. The opacification of a retroperitoneal tumor proved to be an excellent guide for biopsy and irradiation, and can be recommended as a method for following up recurrences or therapeutic failures.

#### SUMMARY

Abdominal aortography and selective angiography of the branches, large and small, of the abdominal aorta were used

systematically to establish the diagnosis in 45 consecutive cases of primary retroperitoneal tumor. No angiographic features peculiar to tumor types were elicited, probably because of the great variety of histologic material encountered. Angiography, nonetheless, proved most helpful for the surgical approach, whether radical removal or an exploratory operation with biopsy was contemplated. In 80 per cent of cases the tumor margins were demarcated, the details of the blood supply defined, and the nature, benign or malignant, correctly diagnosed.

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X

# RADIONUCLIDE BONE IMAGES IN HYPERTROPHIC PULMONARY OSTEOARTHROPATHY\*

By DANIEL W. TERRY, Jr., M.D., ALI T. ISITMAN, M.D., and RICHARD A. HOLMES, M.D. MILWAUKEE, WISCONSIN

IMPORTANT advances have been made in radionuclide bone imaging since the introduction of technetium gom polyphosphate in 197117 and the subsequent development of diphosphonate and pyrophosphate radiopharmaceuticals.3,5 High quality bone images obtained with these agents have allowed earlier diagnosis and localization of a wider range of bone abnormalities than observed with conventional roentgenography. Primary and metastatic neoplasia, inflammatory disease, metabolic abnormalities, and periosteal disorders may frequently be detected on the radionuclide bone image long before they become apparent roentgenographically. Even if such abnormalities are noted on roentgenographic images, the extent of bone involvement can be more easily established and followed with bone imaging.

Periosteal new bone formation which occurs in association with various pulmonary and non-pulmonary diseases has been extensively documented in the medical and radiologic literature. 10,13,15 Recently, case reports have appeared demonstrating the scintigraphic appearance of hypertrophic osteoarthropathy associated with pulmonary malignancy (the Marie-Bamberger syndrome or hypertrophic pulmonary osteoarthropathy). These reports have emphasized the difficulty in differentiating metastatic bone disease from periosteal proliferation. 2714

A recent case of epidermoid lung carcinoma with hypertrophic pulmonary osteoarthropathy (HPO) illustrates the scintigraphic findings in this disease and suggests a specificity of the radionuclide bone image in HPO.

#### REPORT OF A CASE

A 61 year old white male, a chronic smoker, was admitted to the hospital complaining of pleuritic left chest pain, hoarseness, and weight loss of 5 months' duration. Physical examination revealed paralysis of the left vocal cord, dullness and decreased breath sounds in the left upper thorax, painful non-pitting ankle edema, and digital clubbing of all extremities. Cardiac status was normal with no clinically evident deep venous disease. Routine laboratory examinations were normal except for the serum alkaline phosphatase which was at the upper limit of normal. Total atelectasis of the upper lobe of the left lung was seen on initial chest roentgenograms; tomography demonstrated a mass obstructing the left upper lobe bronchus. Cytologic sputum examination demonstrated epidermoid carcinoma which was confirmed by bronchoscopic biopsy.

Whole body skeletal imaging with technetium 99m diphosphonate was used to localize skeletal metastases. No metastatic foci were seen but intense uptake of radionuclide was noted superficially along the distal shafts and metaphyses of both right and left femurs, tibias and fibulas (Fig. 1, A and B). The pattern of uptake produced a "double stripe sign." The double stripe is due to circumferential increased uptake by the cortical bone as viewed tangentially in the bone images (Fig. 2, A-D). Less discrete increased uptake was noted at both mid feet, distal forearms, and wrists (Fig. 1, A and B; and 2, A-D). Corresponding roentgenograms revealed periosteal new bone formation of the type associated with pulmonary disease at the positive bone image sites (Fig. 3, A and B). No roentgenographic changes were seen in the proximal extremities or in the phalanges. Because the patient's poor cardiopulmonary status precluded surgery, treatment with radiation therapy was elected. A total of 4,000 r was administered to the left lung over a 3 week

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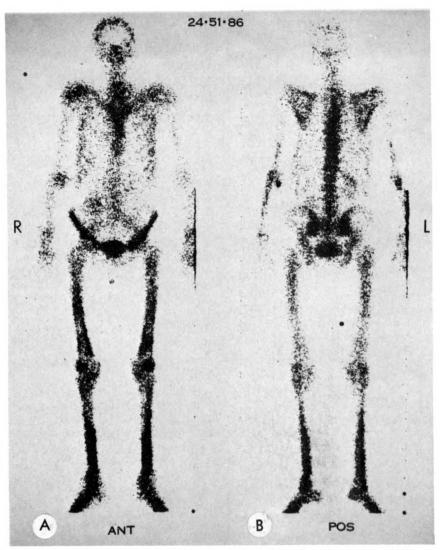


Fig. 1. (A) Anterior and (B) posterior bone images with Tc99m diphosphonate. Especially on the anterior view, intense symmetric circumferential uptake of radionuclide is seen localized to the periosteum of the distal femurs and tibias ("double stripe sign"). Less discrete increased uptake is noted in the forearms, wrists, hands, ankles and feet. Increased uptake at the right elbow is caused by infiltration at the injection site.

period. Symptomatically, the patient improved and his left upper lobe re-expanded. He was discharged to a nursing home but died there 3 months later, before bone imaging and skeletal roentgenography could be repeated.

#### DISCUSSION

More than 8 decades have passed since Marie and Bamberger described hypertrophic pulmonary osteoarthropathy. A bewildering array of pulmonary and nonpulmonary diseases has been described as associated with periosteal proliferation in the long bones. Fischer *et al.*<sup>7</sup> in 1964 reviewed and listed many of these diseases. Since then several additional etiologies have been described. <sup>9,16</sup> They encompass a wide variety of benign and malignant lesions in a number of organ systems. Disorders that have been associated with hypertrophic osteoarthropathy include:

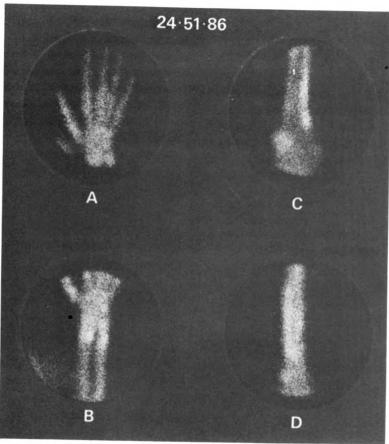


Fig. 2. Selected gamma camera images from Figure 1. (A and B) Increased uptake in the distal radius, carpals, and metacarpals is demonstrated. The phalanges are normal. (C and D) Circumferential uptake localized to the distal femoral and tibial periosteum ("double stripe sign") is shown.



Fig. 3. (A and B) Reactive periosteal new bone deposition is present roentgenographically at the areas depicted in the diphosphonate bone image (arrows).

- I. Primary Hypertrophic Osteoarthropathy
  - a. Pachydermoperiostosis
  - b. Thyroid acropachy
- II. Secondary Hypertrophic Osteoarthropathy
  - a. Benign pulmonary diseases
    Asthma
    Cystic fibrosis
    Bronchiectasis
    Pulmonary abscess
    Pulmonary cyst
    Sarcoidosis
  - b. Malignant pulmonary disease
     Adenoma
     Epidermoid carcinoma
     Pleural mesothelioma
  - c. Mediastinal diseases

    Mediastinal reticulosis

    Hodgkin's disease

    Tumors of thyroid and thymus
  - d. Cardiovascular diseases
    Cyanotic congenital heart disease
    Bacterial endocarditis
    Infected abdominal aortic prosthesis
  - e. Gastrointestinal diseases
    Tumors of esophagus, stomach, and
    liver
    Regional enteritis
    Ulcerative colitis
    Congenital biliary atresia
    Portal cirrhosis

Distinction should be made between digital clubbing and true hypertrophic osteoarthropathy. Clubbing or acropachy is characterized by rounded thickening of the distal phalangeal soft tissues resulting in loss of the normal nail-phalanx angle, without periostosis.7 Hypertrophic pulmonary osteoarthropathy, on the other hand, is characterized histologically by an osteoperiosteal deposit composed of trabecular primitive bone which in its early phase is distinctly demarcated from the underlying cortex. With time the deepest part of the deposit undergoes reconstruction and merges with the cortex. The process is usually symmetrical in distribution and confined to the diaphysis of tubular bones,

tapering toward the metaphysis.10 The proximal and middle phalanges are rarely involved and the terminal phalanges are never involved in spite of the soft tissue "clubbing" which is usually present. The connection between the periosteal new bone formation and the many pulmonary and non-pulmonary diseases associated with it remains obscure. It seems certain, however, that the periosteal reaction does not represent metastasis in the cases of neoplastic disease. Most frequently, osseous metastasis is seen on bone images as asymmetrical deposits of radionuclide in the medullary canal. The deposits are almost always symmetric, circumferential and confined to the periosteum in HPO (Fig. 4, A and B).

The Marie-Bamberger syndrome is perhaps the best known and clinically most significant form of hypertrophic osteoarthropathy. Pain and swelling at the distal ends of the involved bones are the commonest symptoms, although the degree of debility parallels the severity of the underlying disease. The onset of symptoms may be gradual with negative early roentgenographic findings. The "double stripe sign" seen with bone imaging might be the earliest objective indicator of active periosteal deposition.

The mechanism for localization of technetium 99m diphosphonate in areas of periosteal new bone formation remains controversial. The currently accepted hypothesis suggests a process of chemisorption of the radiopharmaceutical onto the hydroxyapatite crystal of cortical bone. More recent experimental evidence suggests that the process may actually involve complexing of the labeled diphosphonate to receptors such as the enzyme alkaline phosphatase.<sup>18</sup> Areas of active bone metabolism showing increased osteoblastic activity have locally increased blood flow and increased alkaline phosphatase activity. Receptor complexing of the labeled diphosphonate could therefore explain its selective periosteal deposition in hypertrophic osteoarthropathy.

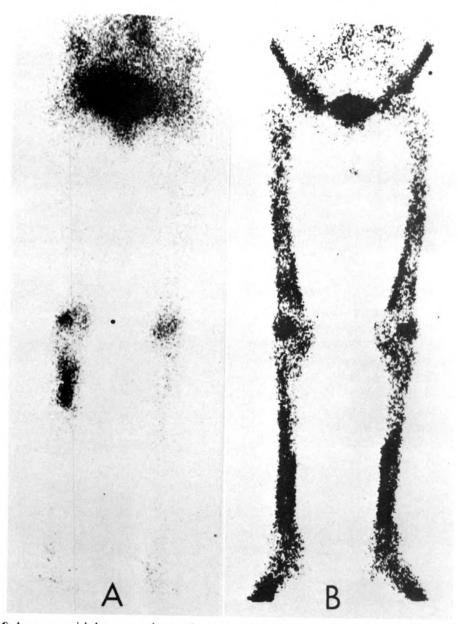


Fig. 4. (A) A woman with breast carcinoma demonstrates the asymmetric medullary uptake of metastasis to the right tibia. (B) Our patient demonstrates the distinct symmetric, circumferential uptake of HPO with normal medullary concentration of radionuclide.

In a patient such as ours, the accurate diagnosis of HPO and its differentiation from bone metastasis are essential, since the choice of therapy rests on this distinction. Resolution of the osteoarthropathy was of hypertrophic pulmonary osteoarthroanticipated in our patient, as tumor control was achieved with radiation therapy<sup>6,8</sup>; unfortunately we were unable to repeat the

bone image when his lung cancer showed the greatest roentgenographic improvement.

Many questions about the pathogenesis pathy are as yet unanswered. What stimulates periosteal proliferation in lung cancer? Is the stimulus removed with therapeutic control of the neoplasm? If it is, how long after control is established will the cessation of appositional bone deposition be expected to convert the labeled diphosphonate bone image to normal? Conversely, if hypertrophic osteoarthropathy is present in lung cancer, can its "disappearance" be considered indicative of cure of the primary disease, or at least a prognostic improvement?

If answers to some or all of these questions are to be obtained, evaluation must include images, roentgenograms, and histologic correlations following the institution of therapy.

#### SUMMARY

Hypertrophic Pulmonary Osteoarthropathy (HPO) can be differentiated from osseous metastasis on conventional bone images using technetium 99m radiopharmaceuticals. Periosteal new bone formation appears as symmetric circumferential deposition of radionuclide in the diaphyseal cortex of tubular bones. In contrast, asymmetrical deposits in the medullary canal are indicative of metastatic disease. The etiologies of hypertrophic osteoarthropathy are discussed.

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# LOCALIZATION OF Tc<sup>99m</sup> POLYPHOSPHATE IN SOFT TISSUE MALIGNANCIES\*

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 $S^{\rm EVERAL}$  phosphate compounds labeled with  $T^{\rm c^{99m}}$  have gained acceptance as agents for imaging the skeletal system. 4,5,6,10,20,27,32,33,34 Recently, there have been several reports by investigators noting uptake in normal breast,24,30 carcinomatous breast,2,30 and in soft tissue neoplasms.25 We have observed radiopharmaceutical localization in patients with squamous cell carcinoma of the lung, adenocarcinoma of the breast, and in several different types of lymphoma. These observations have led us to begin a study of the distribution of Tc99m polyphosphate in the P1798 lymphoma in mice in order to determine the mechanism of localization of this radiopharmaceutical in nonosseous neoplastic tissues.

### MATERIAL AND METHOD CLINICAL STUDY

Ten to 15 mCi of Tc<sup>99m</sup> stannous polyphosphate† was intravenously injected into patients referred to the nuclear medicine division for a bone scan. Anterior and posterior views were obtained 3 hours post injection with the Raytheon Dual probe rectilinear scanner.‡ Approximately 500 bone scannings performed during the past 18 months were analyzed for the presence of radiopharmaceutical localization in soft tissue neoplasms.

#### ANIMAL STUDY

BALB/C mice were transplanted with 10<sup>7</sup> cells each of the P1798 solid lymphoma. We tested the null hypothesis that there would be no difference between the tumor

† New England Nuclear Corporation Lots 4001–4009. ‡ Model 625. localization of Tc<sup>99m</sup> pertechnetate and Tc<sup>99m</sup> polyphosphate. This was done to determine whether the localization of Tc<sup>99m</sup> polyphosphate, should it occur, was due to specific concentration or a nonspecific effect.

#### RESULTS

#### CLINICAL STUDY

Case 1. R.B. A 52 year old male had a 6 week history of a right submandibular mass. On physical examination there was a firm, slightly tender mass in the right submandibular area measuring 4×4 cm. A bone scan demonstrated a clearly defined area of abnormal uptake (Fig. 1). The biopsy of the mass showed reticulum cell sarcoma.

Case II. D.M. A 6r year old female had a poorly differentiated carcinoma of the left breast. On physical examination there was a firm right submandibular lymph node measuring 2 cm. in diameter. A bone scan demonstrated a small area of increasing radioactivity in the right submandibular region corresponding to the palpable lymph node (Fig. 2).

CASE III. J.C. A 65 year old male had nodular lymphocytic lymphosarcoma. Physical examination revealed generalized lymphadenopathy. His chest roentgenogram showed a large right hilar mass and an anterior mediastinal mass. A bone scan demonstrated uptake in a paramedian location corresponding to the mediastinal mass (Fig. 3).

CASE IV. J.H. A 64 year old male with squamous cell carcinoma of the lung. A bone scan demonstrated concentration of activity in the right parasternal region corresponding in location to the patient's primary lesion as seen on the accompanying chest roentgenogram (Fig. 4).

<sup>\*</sup> Presented at the Seventy-fifth Annual Meeting of the American Roentgen Ray Society, San Francisco, California, September 24-27, 1974. \*
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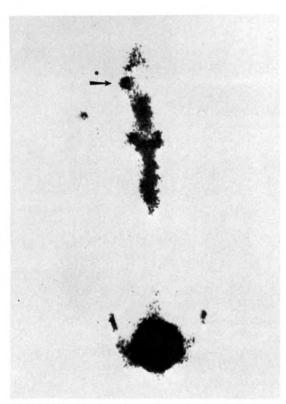


Fig. 1. Uptake in the right submandibular area (arrow). Biopsy of the mass showed reticulum cell sarcoma.

Case v. G.T. A 56 year old female was seen 7 years after a left mastectomy for moderately well differentiated adenocarcinoma. She presented with a 3 month history of a right axillary mass which proved to be metastatic adenocarcinoma. A  $5 \times 3$  cm. firm, slightly tender mass was palpable in the right axilla. A bone scan revealed an area of uptake in the right axilla (Fig. 5).

#### ANIMAL STUDY

The uptake of both  $Tc^{99m}$  as the pertechnetate (controls) and as the polyphosphate appears to be time dependent (Fig. 6). When the tumor to muscle ratios of the means were tested for the control and test animal at each time interval, no significant difference was observed (t=0.05) except at the  $6\frac{1}{2}$ — $7\frac{1}{2}$  hour post injection interval§ (Table I); this, we suspect, was due to the small number of animals. In fact, no signifi-

§ A subsequent experiment with 3 additional animals for each radiopharmaceutical indicates no significant difference (t=0.05) in the tumor to muscle ratios at 7 hours.

cant difference was observed at t=0.025. Bone to muscle uptake ratios between the control and test animals were clearly significant at each time interval.

#### DISCUSSION

There has been a constant striving to develop a tumor-seeking radiopharmaceutical. The use of such an agent would enable the noninvasive assessment of both the distant metastatic spread and the local extent of neoplasia. Such a radiopharmaceutical would act in a fashion complementary to conventional roentgenographic methods.

Strontium 87m has been recommended as a tumor-seeking radiopharmaceutical by several authors.<sup>7,8,9,26,29</sup> The oncostatic drug bleomycin labeled with Tc<sup>99m 22</sup> or Indium III<sup>15</sup> has been used, as has Tc<sup>99m</sup> tetracycline.<sup>13,18,19</sup>

Gallium 67 citrate was initially thought to be a tumor localizing agent.<sup>14,17,35</sup> It has favorable characteristics such as availabil-

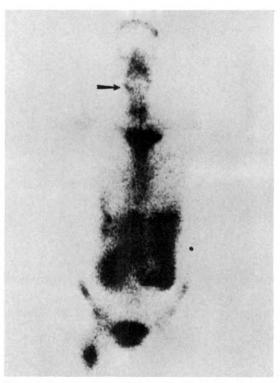
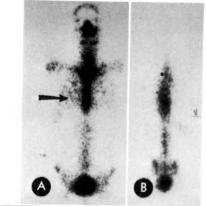


Fig. 2. Anterior scan. Uptake in the right submandibular area (arrow). The patient had adenocarcinoma of the breast.

ity in a carrier-free state and moderate gamma ray energies of 184 and 296 KeV. However, it became apparent that it is not tumor specific; it localizes in inflammatory and in infarcted tissues. 1,16,21,23,28 The fact that gallium 67 localizes in non-neoplastic tissues suggests a nonspecific mechanism for the tumor uptake.

The Tc99m phosphates have been used as bone scanning agents. We have noted uptake in soft tissue neoplasms as well. While the exact pharmacologic mechanism of this uptake is unknown, several possibilities have been suggested: (1) It may involve bonding to hydroxyapatite crystals. Mitochondria with hydroxyapatite crystals are present in some necrotic tissues, 11,12,31 and phosphate moieties may become chemically bonded to these crystals. This is the basis upon which Tc99m pyrophosphate has been thought to localize in recently infarcted myocardium.3 (2) It may be related to regional differences in local blood flow.5 (3) It may be due to a localized decrease in pH in the tumor. The lower pH is thought to be the result of increased anaerobic glycolysis with resultant lactic acid production. 29,35 This change in pH may act in one of two ways to lead to radioisotope concentration. There may be increased tumor tissue affinity for the Tc99m polyphosphate. There may



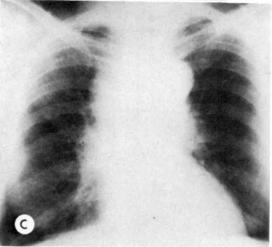


Fig. 3. (A) Anterior scan. (B) Posterior scan. (C) Roentgenogram of chest. Uptake in a paramedian location (arrow in A) corresponding to the mediastinal mass seen on chest roentgenogram (C).

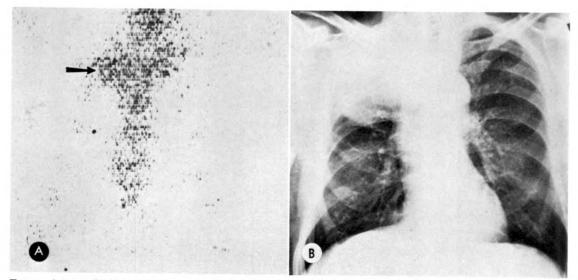


Fig. 4. (A and B) Uptake in the parasternal area (arrow) corresponding to the patient's primary lesion as seen on the accompanying chest roentgenogram. The patient had squamous cell carcinoma of the lung.

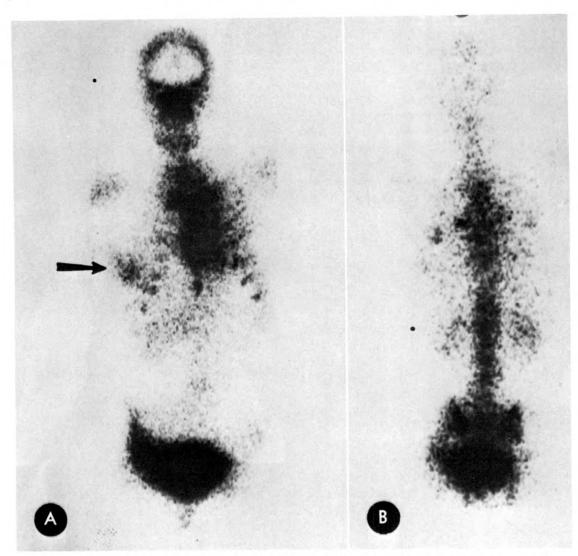


Fig. 5. (A) Anterior scan. (B) Posterior scan. Uptake in the right axilla (arrow in A) in a patient with metastatic adenocarcinoma of the breast.

be a release of reduced  $Tc^{99m}$  from the labeled polyphosphate at the lower pH with resultant enhanced binding of free, reduced  $Tc^{99m}$  by the tumor. We are currently investigating this latter possibility by conducting a similar experiment using reduced  $Tc^{99m}$  as an additional control.

Our data so far do not provide a clear explanation of the localization of Tc<sup>99m</sup> polyphosphate in soft tissue tumors. The results tend to suggest that there is a nonspecific mechanism for this localization. We suspect that this property is shared by

those radiopharmaceuticals that have been observed to localize in soft tissue tumors. We plan to see if this nonspecificity exists with other tumor types. We will also compare the soft tissue tumor to muscle ratios obtained with the labeled polyphosphate to that exhibited by the other soft tissue tumor localizing drugs.

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TABLE I

Time Sacrificed Post Injection (hours)	Tumor: M		
	Tc-99m Pertechnetate	Tc-99m Polyphosphate	t-test 0.05
$1\frac{1}{2}$ $2\frac{1}{2}$	0.84±0.44 (5)	0.74±0.37 (7)	Not significant
$3-3\frac{1}{2}$	1.75±0.53(5)	$2.01 \pm 0.61 (5)$	Not significant
$6\frac{1}{2}$ $7\frac{1}{2}$	$2.05\pm0.47$ (2)	1.06±0.36 (3)	Not significant (0.025) Significant (0.05)
$16\frac{1}{2}$ $-17\frac{1}{2}$	3.33±0.51 (3)	$3.43 \pm 0.87 (3)$	Not significant

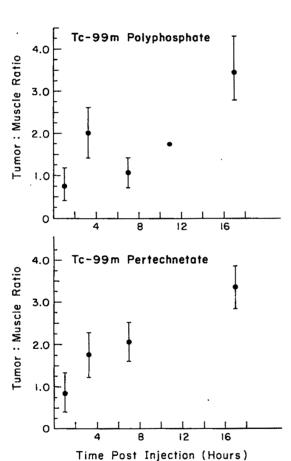


Fig. 6. Uptake of the pertechnetate and polyphosphate.

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## BRAIN SCAN IN CEREBROVASCULAR "MOYAMOYA" DISEASE\*

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EREBROVASCULAR "Moyamoya" disease is characterized by peculiar angiographic features which consist of an abnormal net-like blood vessel pattern in the base of the brain associated with narrowing or occlusion of both internal carotid arteries at the level of the siphon.8 This disease has been described under many different names such as "spontaneous occlusion of the circle of Willis,"6 "multiple progressive intracranial arterial occlusion,"9 "Nishimoto-Takeuchi-Kudo disease,"10 etc. Although the Japanese author Kudo considered this disease limited to the Japanese race,6 similar angiographic findings have been reported in countries other than Japan. 3,4,7,9,10

To our knowledge, there are very few reports of radioisotopic studies in this disease. It is a generally held belief that this disease shows a normal brain scan. The purpose of this paper is to report 2 cases which presented abnormal brain scans and to discuss the significance of radioisotopic studies.

#### REPORT OF CASES

Case I. The patient was a 19 month old Japanese girl admitted because of left-sided hemiplegia and facial palsy. Ten days prior to admission, she had an episode of right-sided convulsions which lasted about 15 minutes followed by hemiplegia of 12 hours' duration. On admission she was suffering from measles, but the rash and Koplik's spots disappeared after I week. The lumbar puncture and other routine laboratory studies were normal. The electroencephalogram showed  $\delta$ -wave pattern usual in a sleeping record.

Dynamic and static brain scannings with Tc<sup>99m</sup>O<sub>4</sub>— were performed about 20 days after the first symptoms using a Picker Dyna Camera

2 C. The dynamic study, which was obtained in anterior view, showed decreased perfusion in the right hemisphere during the arterial to capillary phase and retention of activity in the venous phase, particularly about the lower portion of the right hemisphere (Fig. 1). The static scans were obtained at 2 hours, and showed abnormal radioactivity in the right parietal, the right temporal, and the left parasagittal areas of the frontal region (Fig. 2).

On right cerebral angiography, narrowing was demonstrated at the carotid bifurcation and in the middle cerebral artery, accompanied by a fine hazy vascular pattern. The anterior cerebral artery was not opacified, suggesting complete occlusion. On left cerebral angiography there were a stenosis at the origin of the anterior cerebral artery and a mild dilatation of the middle cerebral artery as well as the posterior cerebral artery. The latter showed collateral circulation with external occipital arteries (Fig. 3).

The second scanning was performed about 40 days after the first symptoms. The dynamic study showed almost the same pattern as the first study, but the static brain scans returned to normal.

Case II. The patient was a 16 year old girl. She had her first attack of unconsciousness 16 months before admission and recovered from the unconsciousness in a week, but right-sided facial palsy and mild hemiplegia remained for several weeks. These symptoms disappeared gradually and she was well until 18 days before this admission, when she had a second episode of speech disturbance, right-sided hemiplegia and facial palsy. She was placed on conservative therapy, but there was no improvement. She was, therefore, referred to Kanazawa University Hospitals for further examination. Her family history was unremarkable. She had had measles in early childhood and tonsillectomy at age 12.

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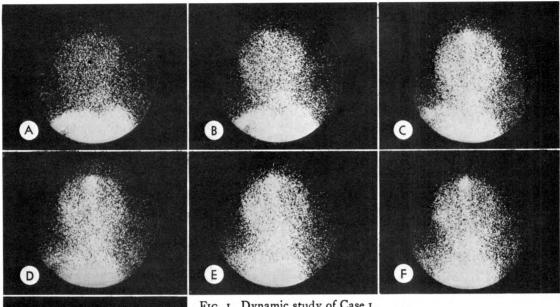


Fig. 1. Dynamic study of Case 1.

(i) Early scans show decreased radioactivity in the right hemisphere (A, B) and following scans show prolonged circulation in the same side, especially about the lower portion (C-F).

(ii) The time activity curves obtained from lower half of each cerebral hemisphere show a delayed peak in the right side (G). (Each dot means 0.4 second. Top is right, middle is left, and bottom is superimposed).

On this admission lumbar puncture and other routine laboratory studies were normal. The electroencephalogram showed an asymmetrical slow-wave pattern generally.

On cerebral angiography both carotid arteries were occluded at their bifurcations and there was the characteristic net-like vasculature of "Moyamoya" disease extending even into the ophthalmic artery (Fig. 4). In this case, the same hazy appearance was also seen in the vertebral angiogram, particularly in the posterior choroidal and dorsal callosal arteries.

Four weeks after her second attack, a brain scan was obtained with 6 millicuries of indium-113m DTPA ascorbic acid using a dual probe isosensitive scanner. This showed abnormal crescentic radioactivity in the left perivascular rim on an anteroposterior view, and inverted triangular radioactivity in the frontal region on the lateral view (Fig. 5).

#### DISCUSSION

It has been said that most cases of cere-

bral "Moyamoya" disease show a normal brain scan. Hilal et al.4 reported the first case in which the brain scan using RISA showed a bilateral radioactive uptake in the basal ganglia and the uptake decreased during a 48 hour observation. On the other hand, the site of abnormal uptake in each of our 2 cases did not correspond to the basal ganglia but was seen at the periphery. The brain scan in Case I revealed abnormal tracer retention in the distribution of the right anterior, right middle, and left anterior cerebral arteries; and in Case II it showed an abnormal uptake in the zone between the distribution of the left anterior and middle cerebral arteries. In Case 1, a second study about 6 weeks later showed return to normal. These spatial and temporal scan patterns are typical of infarction.

Because of very few postmortem examinations, little is known about the etiology and pathogenesis of "Moyamoya" disease.

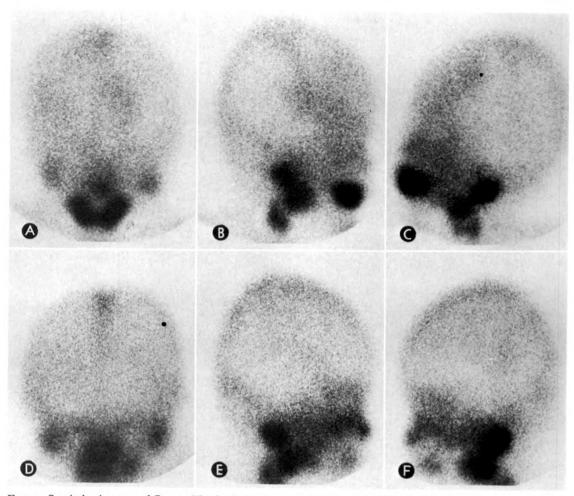


Fig. 2. Static brain scan of Case 1. The brain scan obtained about 20 days after the initial symptom shows abnormal areas of increased activity in the right parietal, the right temporal and the left frontal region (A-C). The second scan done at 40 days after the initial symptom shows no abnormality (D-F).

However, on the basis of the autopsies of 7 patients, Hosoda<sup>5</sup> suggested that mural thrombi could take at least a part in the progress of this disease. Although we have no anatomic verification of the pathologic process in any of our patients, this hypothesis would conveniently explain the mechanism of the abnormal brain scan. It would also explain the abnormal uptake in the distribution of the left anterior cerebral artery in Case I—for a shower of emboli resulting from mural thrombi could easily reach the opposite anterior cerebral artery distribution if the anterior communicating artery was patent—a phenomenon well known to arteriographers.1 Although the

previous paper indicates that patients with transient ischemic attack (TIA) have positive brain scans,<sup>2</sup> the findings of abnormality by brain scan is extremely low (3 per cent) and each of our 2 cases was not thought to have TIA from a clinical standpoint.

In our hospital, brain scans have been performed in each of the 6 patients with this disease and were found to give negative results except for the 2 cases reported in this paper. All 4 cases with negative brain scans were adults whose scans were obtained between 2 and 5 weeks after the attacks of subarachnoid hemorrhage. The low incidence of positive scans among adults

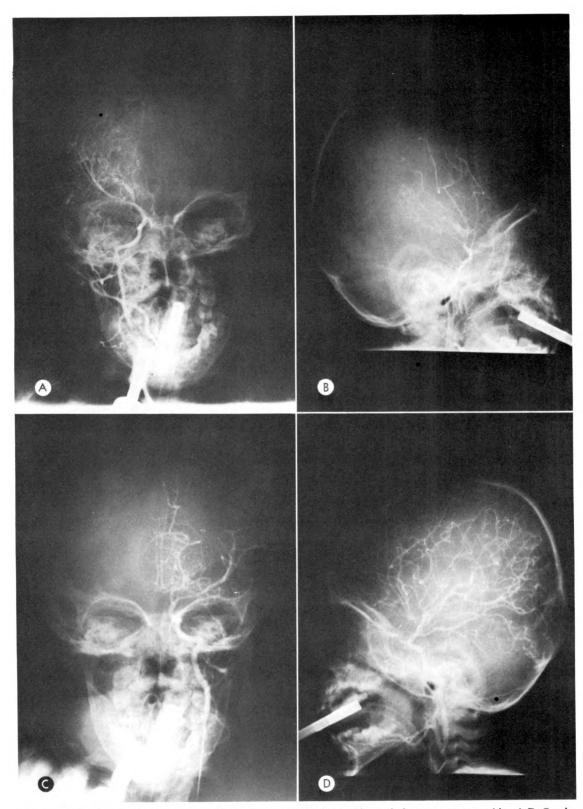


Fig. 3. Cerebral angiogram of Case 1. Bilateral anteroposterior and lateral views are presented in A-D. On the right side, a stenosis of carotid bifurcation as well as middle cerebral artery, accompanied with fine hazy vascular pattern. There is no opacification of anterior cerebral artery. On left side, a stenosis at anterior cerebral artery together with a mild dilatation of both middle and posterior cerebral artery are noted: also note collateral circulation with occipital artery.

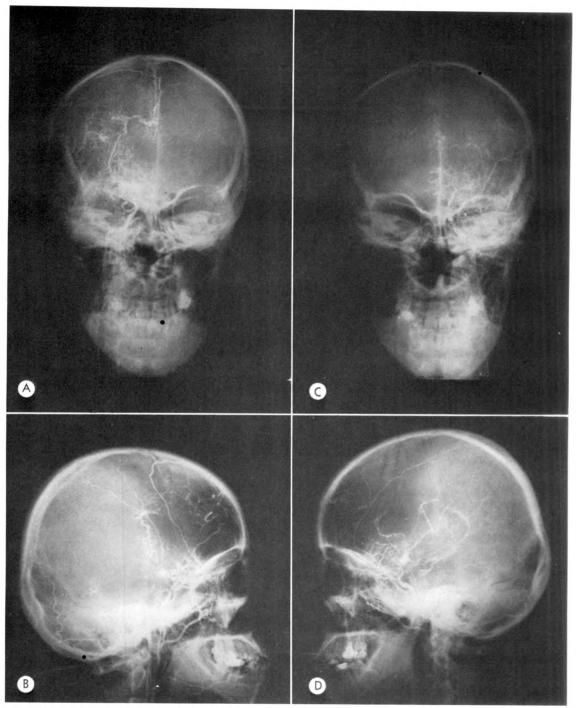


Fig. 4. Cerebral angiogram of Case II. Bilateral anteroposterior and lateral views are presented in A-D. Occlusions at both carotid bifurcation with net-like vascular structure are clearly seen.

with this disease may be attributed to 2 factors:

(1) As noted before, in the adult group the disease tends to appear primarily with subarachnoid hemorrhage, whereas the

most representative symptoms appearing in the juvenile group are disturbance of cerebral function due to cerebral ischemia. Therefore, the adult group has a lower incidence of positive

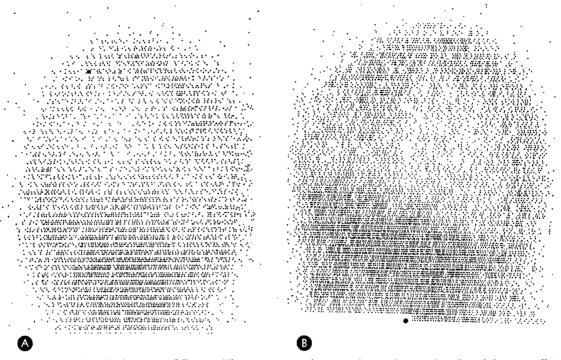


Fig. 5. Isosensitive brain scans of Case II. The anteroposterior scan shows abnormal radioactivity, so-called crescentic pattern at the left hemisphere (A). In the lateral view, the abnormal radioactivity is an inverted triangular pattern at the frontal region (B).

scan than the juvenile group.

(2) The abnormalities may be not demonstrable in brain scans performed in the first few days or several months after attack, just as in cases of conventional vascular thrombosis or embolism.

Radionuclide angiography performed in Case I revealed reduction in the appearance of tracer activity in right middle cerebral artery perfusion beds and prolonged circulation on the same side. The latter may be due to the rich "Moyamoya" vessels and may be identical with the uptake of a vascular malformation described by Hilal et al.<sup>4</sup>

In regard to the etiology and pathophysiology, there are still many problems unsolved. We believe, however, that radionuclide angiography, radioisotope cisternography, and regional cerebral blood flow study (rCBF) as well as conventional brain scans could help in solving these problems.

#### SUMMARY

Brain scans were abnormal in 2 of 6 patients with cerebral "Moyamoya" disease. The spatial and temporal scan patterns were analogous to those described in conventional cerebral infarction. Cerebral infarction due to emboli resulting from mural thrombi may explain the uptake of radioisotope. None of the scans was abnormal in 4 adult patients in which the disease was complicated by subarachnoid hemorrhage.

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### INTERNAL HEPATIC RADIOTHERAPY: I\*

ORGAN DISTRIBUTION OF COLLOIDAL Cr32PO4 INJECTED INTO A PERIPHERAL VEIN, THE PORTAL VEIN, OR THE ARTERIAL SUPPLY OF THE GASTROINTESTINAL TRACT IN THE RAT

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RRADIATION, both internal and external, has been well established as treatment of many malignancies. There has been little success in controlling established metastatic cancer of the liver. The incidence of likely metastasis from colon cancer can be estimated by establishing the extent of the primary lesion in the abdomen at the time of its resection. Since the probability of metastasis to the liver can be calculated in many cases, it seems logical to treat highly susceptible patients as though the disease was already there, but not in a detectable stage. There is evidence that the surgical removal of an abdominal primary lesion may cause tumor cells to break off in the veins and be carried to the liver.3,5 It is definitely easier to treat this disease in its early stages than to wait until the disease has progressed to a point where only palliative results can be obtained.

#### PLAN

We propose to treat occult metastatic cancer of the liver by internal radiation therapy using Cr<sup>32</sup>PO<sub>4</sub> colloid suspension. It is necessary to establish the safety and effectiveness of the therapy so that a patient who is treated with the Cr<sup>32</sup>PO<sub>4</sub> colloid does not endure an unnecessary risk. Ackerman *et al.*<sup>1</sup> have shown that Cr<sup>32</sup>PO<sub>4</sub> injected intravenously reduces the number of cancer "takes" in rats when tumor cells are injected into the liver. We intend to confirm that work and show that Cr<sup>32</sup>PO<sub>4</sub> colloid therapy has acceptable risks if administered in an appropriate manner.

We chose Cr<sup>32</sup>PO<sub>4</sub> colloid for internal irradiation for a number of reasons: (1) it

requires no shielding of the patient; (2) the beta emission energy maximum is 1.8 MeV which gives a half layer penetration in tissue of 3 mm.; (3) the Cr<sup>32</sup>PO<sub>4</sub> is very stable;<sup>2</sup> (4) the Cr<sup>32</sup>PO<sub>4</sub> is easily obtained and inexpensive; (5) the particle size is less than 2.0 microns; (6) the colloid is rapidly phagocytized by the reticuloendothelial system.

In previous work Y<sup>90</sup> tagged resin microspheres (15±5 microns) were injected through the portal vein of rats.<sup>6</sup> This route gave unsatisfactory results because of non-homogeneous distribution in the liver due to stream-lining effects in the blood (Fig. 1).

#### METHOD.

Three routes of injection were compared: intravenous; intraportal vein; and the arterial supply of the gut. Sprague-Dawley female rats weighing 200 gm. each were anesthetized using 0.05 mg. pentobarbital per gram of body weight injected intraperitoneally. The intravenous injection was done by exposing the femoral vein and injecting 0.2 ml. of Cr32PO4 colloidal suspension containing 100 microcuries activity using a No. 25 g-butterfly infusion set. The Cr32PO4 was followed by a 1.0 ml. normal saline flush. Hemostasis was secured and the incision closed. For the portal vein injection laparotomy was performed and the portal vein exposed. Injection was by same method as above. For the arterial injection laparotomy was performed and the aorta exposed. The right renal artery and the aorta below the superior mesenteric artery and above the left renal artery were temporarily occluded. Direct syringe injection

<sup>\*</sup> From the Frank H. Neely Nuclear Research Center, Georgia Institute of Technology, and the Departments of Surgery and Nuclear Medicine, South Fulton Hospital, Atlanta, Georgia.

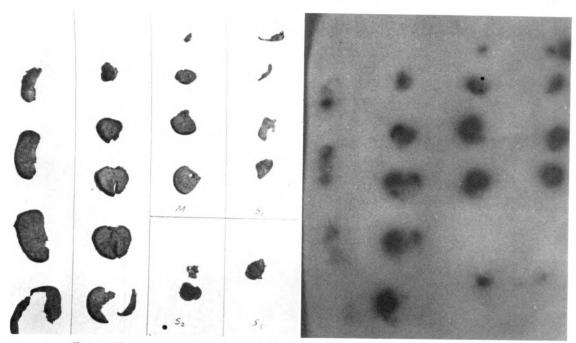


Fig. 1. Photograph (left) and autoradiograph (right) showing uneven radioactivity in liver slices after Y<sup>90</sup> portal vein injection.

was made into the aorta above the superior mesenteric artery so that the Cr<sup>32</sup>PO<sub>4</sub> was shunted through the superior mesenteric and celiac arteries (Fig. 2).

The Y<sup>90</sup> microsphere injection into the portal vein was used in 9 rats, the intravenous colloid procedure was done in 25, portal vein colloid in 25, and intra-arterial colloid in 25.

The rats were sacrificed I day after injection. The following organs were dissected out and prepared for counting: liver, spleen, lungs, kidneys, ovaries, heart, brain, and gastrointestinal tract. A sample of the following was taken: muscle, bone and bone marrow. The livers were fixed in formalin and then sliced into sections I.5 to 2.0 mm. thick. These slices were placed on 8 inch × 10 inch x-ray film for autoradiographs. Photographs were taken of the position of the liver slices so that the distribution of the phosphorus-32 within the liver could be determined.

The liver and other organs were ashed and the activity counted in a low beta counter or in a gas flow counter. These counts were compared to the counts of a standard and the results expressed as a percentage of the total amount injected if the whole organ was counted or as a per cent of the total injected dose per gram of tissue counted if only part of the organ such as muscle, bone or bone marrow was counted.

A standard for counting was prepared by placing an equal amount, 0.2 ml., of the dose injected in the rats in a 100 ml. volumetric flask and brought to volume with distilled water. A 10 ml. volumetric pipet was used to transfer 10 ml. of liquid from this flask to another 100 ml. volumetric flask which was brought to volume with distilled water. This was done once more and then three 1.0 ml. aliquots were taken from each flask and dried on planchets.

#### RESULTS

The distribution of the Cr<sup>32</sup>PO<sub>4</sub> within the liver using the portal vein method was nonhomogeneous (Fig. 3), which was attributed to stream-lining in the blood. This method had the highest uptake in liver and lowest uptake in the other organs compared

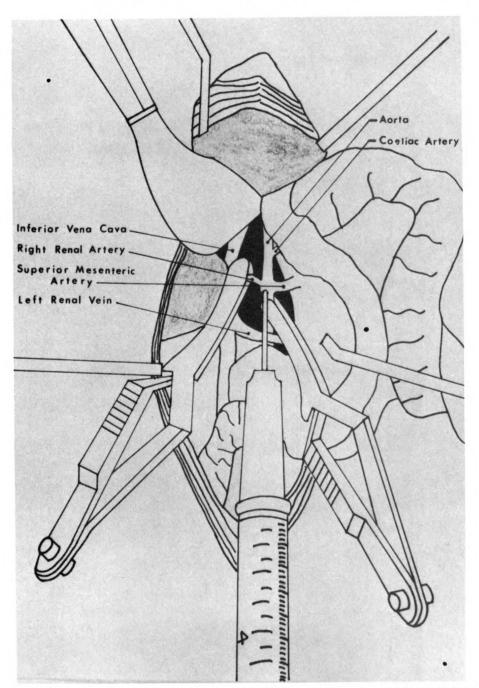


Fig. 2. Diagram of aortic injection method so that Cr32PO4 colloid enters enteric arterial supply.

to the other two methods of injection (Table 1).

The intravenous injection route gave an excellent homogeneous distribution of the radioactivity in the liver (Fig. 4) but the uptake of radioactivity in the bone marrow

was almost 3 times that by the portal vein method or the intra-arterial method.

The distribution in the liver using the enteric intra-arterial method of injection was homogeneous (Fig. 5). The amount of activity found in the bone marrow was

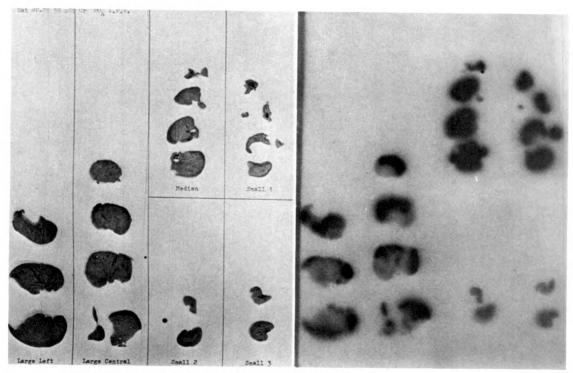


Fig. 3. Photograph and autoradiograph of liver slices showing uneven radioactivity following Cr32PO4 colloid injection into portal vein.

comparable to that of the portal vein injec- intra-arterial method than by the other two tion (Table 1). The amount of activity found in the spleen was higher than by the portal vein route of injection. The activity

methods of injection but still within acceptable limits.

The amount of activity excreted in the found in the gut was higher by the enteric urine and feces was a very small amount of

TABLE I PER CENT ADMINISTERED DOSE

	Enteric Intra-arterial		Porta	al Vein	Intravenous		
Organ	Total Organ	Per Cent Per Gram	Total Organ	Per Cent Per Gram	Total Organ	Per Cent Per Gram	
Liver	70.330	6.364	75.550	6.837	70.740	6.402	
Spleen •	2.528	6.320	.708	1.770	4.392	10.980	
Lungs	.300	.252	.197	.166	.863	.725	
Kidneys (EA)	.043	.039	.027	.025	.087	.080	
Heart	.019	.023	.020	.024	.057	.070	
Brain	.004	.002	.004	.002	.009	.005	
Ovaries	.017	.019	.009	.010	.024	.026	
Muscle		.006		.005		.012	
Bone		.080		.090		.174	
Bone Marrow		•493		.430		1.217	
Stomach	.132	.099	.025	.019	.040	.030	
Intestine .	.492	.117	.105	.025	.109	.026	
Cecum and Rectum	. 198	.084	.059	.025	.071	.030	

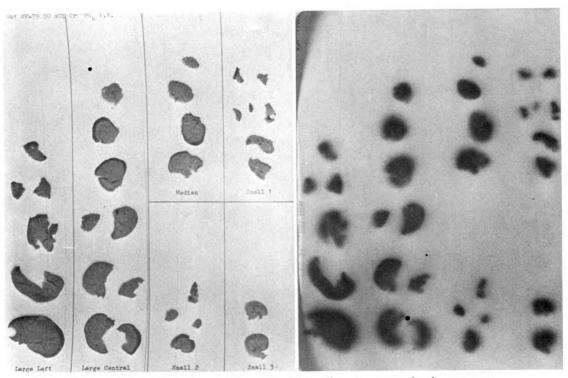


Fig. 4. Photograph and autoradiograph of liver slices demonstrating homogeneous radioactivity following peripheral intravenous injection.

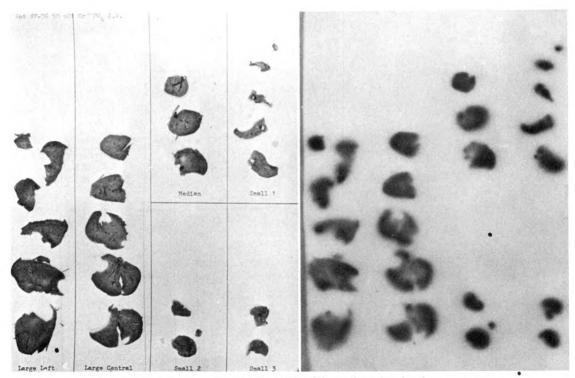


Fig. 5. Photograph and autoradiograph of liver slices showing homogeneous irradiation following enteric arterial injection.

X

the total injected dose. For intravenously injected rats the amount found in the urine was 0.068 per cent per day over a 55 day period and the amount found in the feces was 0.049 per cent per day over a 25 day period. In the intra-arterially injected rats the amount found in the urine was 0.046 per cent per day over a 55 day period and the amount found in the feces was 0.045 per cent per day over a 25 day period.

#### DISCUSSION

Metastatic cancer of the liver is a disease that once clinically established can only be treated with palliative results, with rare exceptions, and has been reported in 64 per cent of patients originally operated "for cure."4 We propose to treat the disease with a prophylactic dose of internal irradiation using Cr<sup>32</sup>PO<sub>4</sub>. Ackermanet al. have demonstrated in rats the effectiveness of preventing simulative metastasis when injecting Cr32PO4 intravenously. Our work shows that with an intravenous isotope injection the bone marrow has a high uptake of the Cr<sup>32</sup>PO<sub>4</sub>; however, when injected by the enteric intra-arterial method the amount of bone marrow Cr<sup>32</sup>PO<sub>4</sub> uptake is approximately one-third that of the intravenous route. We believe this difference is significant as the bone marrow is a radiosensitive organ. The enteric intra-arterial injection method accomplished the basic goals of homogeneous distribution of radioactivity within the liver, with a low level of systemic radioactivity, except in the spleen, and no evidence of radiation hazard to environment or attendants.

The distribution of the radiation within the liver is also critical because the effective distance that the beta particles from the P<sup>32</sup> travels is only 3 mm. It can be seen that

if an even distribution is not obtained, there may be areas which receive little or no irradiation, hence any malignant cells in such an area will not be treated and may continue to grow. Both the intra-arterial and intravenous route give homogeneous distribution as shown in the autoradiographs. The intraportal vein route, while having the lowest bone marrow uptake, had an unacceptable nonhomogeneous distribution.

The method described produces localized, concentrated irradiation within the liver, and except for the spleen, spares other organs from high radiation dose. The results are predictable and reproducible.

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## INTERNAL HEPATIC RADIOTHERAPY: II\*

### INTRA-ARTERIAL RADIOCOLLOID THERAPY FOR HEPATIC TUMORS

By EDGAR D. GRADY, M.D., THOMAS R. NOLAN, M.D., A. J. CRUMBLEY, M.D., JAMES H. LAROSE, M.D., and WILLIAM V. CHEEK, B.S.

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ANY patients who undergo operation for colo-rectal carcinoma have overt liver metastases, and we believe that they should be treated by means of intra-arterial radioisotope therapy in an attempt to eliminate clinical metastases. 6,7,9 Others, a significant fraction, have evidence that suggests they are likely to develop such metastases. This evidence may be serosal extension, multiple regional nodal metastases or blood vessel invasion.3 These patients would be greatly benefited if there was a practical effective method of preventing overt metastases with minimal significant systemic or local side effects. We have attempted to develop such a method, by localized internal radiation therapy.

Our previous work<sup>8</sup> has shown that radioactive colloids injected into the isolated visceral circulation concentrate in the liver and are distributed as shown in Table 1. Note that there is approximately the same amount of radiation in the liver by enteric intra-arterial injection as in systemic intravenous injections. The spleen dose is highest for systemic intravenous injection and least for portal vein injection. At the same time, with enteric intra-arterial injection the bone marrow dose is  $\frac{1}{3}$  that of intravenous injection. This method maintains a high dose in the liver but significantly reduces bone marrow exposure.

The present study was designed to evaluate the efficacy of internal hepatic radionuclide therapy with respect to reducing hepatic metastases.

#### MATERIAL AND METHOD

Sprague-Dawley female rats weighing 200 gm. each were kept under standard

laboratory and diet conditions. Operations were performed under intraperitoneal sodium pentobarbital anesthesia, 0.05 mg./ gm. body weight and with sterile techniques. Walker-256 carcinomas were harvested from colony animals and a cell suspension prepared so that 8×106 cells were injected into the portal vein. Two days later in animals to be treated, P32 chromic phosphate colloid was injected into the abdominal aorta in a temporarily isolated segment containing the origins of the celiac and superior mesenteric arteries. The dose of 100 microcuries was calculated to deliver 5,000 rads to the liver. Control animals were given tumor cells only.

Observations of tumor growth were done by laparotomy at 21 days and again at 35 days or autopsy was done when the animal died earlier from cancer. Animals which died immediately after either surgical procedure or from other causes before observation were excluded from analysis of both control and treated groups. Each time animals were treated, there were also control animals injected with the same tumor cell suspension.

In order to observe distant and systemic radiation effects, blood counts were done on survivors at intervals and bone marrow specimens were also examined.

#### RESULTS

Table II shows the numbers of animals, those excluded and those in each group. Of 101 determinate control animals (Table III), 53 died of cancer while of 102 animals treated with P<sup>32</sup> colloid, 21 died of cancer. Therefore, 52 per cent of control animals developed cancer but only 25 per cent of

<sup>\*</sup> From the Departments of Surgery and Nuclear Medicine, South Fulton Hospital, and The Frank H. Neely Nuclear Research Center, Georgia Institute of Technology, Atlanta, Georgia.

Table I

PER CENT ADMINISTERED DOSE

	Enteric In	tra-arterial	Porta	al Vein	Intra	venous
Organ	Total Organ	Per Cent Per Gram	Total Organ	Per Cent Per Gram	Total Organ	Per Cent Per Gram
Liver	70.330	6.364	75.550	6.837	70.740	6.402 ;
Spleen	2.528	6.320	.708	1.770	4.392	10.980
Lungs	.300	.252	.197	.166	.863	.725
Kidneys (EA)	.043	.039	.027	.025	.087	.080
Heart	.019	.023	.020	.024	.057	.070
Brain	.004	.002	.004	.002	.009	.005
Ovaries	.017	.019	.009	.010	.024	.026
Muscle	·	.006	-	.005	•	.012
Bone	•	.080		.090		.174
Bone Marrow	_	•493		.430		1.127
Stomach	.132	.099	.025	.019	.040	.030
Intestine	.492	.117	. 105	.025	.109	.026
Cecum and Rectum	.198	.084	.059	.025	.071	.030

treated animals did so. These data represent a 61 per cent decrease in the establishment of liver cancers following treatment. The data were submitted to chi square analysis and the difference was significant, p < 0.001.

Follow-up on survivors has failed to show adverse systemic hematologic effects. Following therapeutic injection the peripheral blood showed no evidence of white blood cell depression, as noted in Table IV. In fact, animals TP-170 and TP-174, which developed massive wound infections, were able to mobilize a leukocytosis response.

In order to observe bone marrow effect directly, 3 separate animals were given 430 microcuries Cr<sup>32</sup>PO<sub>4</sub> intravenously.

Table II
NUMBERS OF ANIMALS

Total			290
Excluded (surgical or other early mortality)			87
Determinate	animals		203
	Control	101	
•	Treated	102	
		-	

That dose was 4.3 times the therapeutic dose, and bone marrow uptake by this route is approximately 3 times that of the test method. In these animals, at 26 days after injection, the bone marrow appeared completely normal by standard microscopic examination. Another 3 animals were given 1,000 microcuries Cr<sup>32</sup>PO<sub>4</sub> intravenously, and radiation toxicity data are recorded in Table v. This dose appears lethal.

#### DISCUSSION

In order to be effective as a prophylactic method, internal liver radiation must meet several criteria. The radiation dose must be tumoricidal at the subclinical level, but not great enough to produce clinical liver damage, or systemic radiation effects in the critical organ at significant levels. After the liver, which is the target organ, the critical

Table III

GROWTH OF CANCER IN LIVER; IN THE ABSENCE
OF LIVER TUMOR, THERE WAS NONE
ELSEWHERE IN THE ANIMAL

	Cancer	No Cancer	Total
Control	53	48	101
Treated	21	81	102

TABLE IV
PERIPHERAL BLOOD CELL COUNTS

Rat No.	Dose Cr <sup>32</sup> PO <sub>4</sub> μc	Route of Injection	Days Post Injection	WBC×103	RBC×106
P32	100	I.P.V.	455	9.15	9.14
P-33	100	I.P.V.	455	7.25	7.37
P-114	100	I.A.	345	7.05	9.8
P-173	100	I.A.	397	4.8	6.3
P-174	100	I.A.	397	7.1	8.9
P-175	ÌOO	I.A.	397	4. I	6.4
P176	100	I.A.	382	4.2	6.3
TP99	100	I.A.	329	7.8	6.87
TP-132	100	I.A.	243	7.6	12.5
TP-134	100	I.A.	243	5.5	8.2
TP-148	100	I,A.	229	5.9	7.5
TP168	100	I.A.	209	6.6	9.0
TP170	100	I.A.	34	24.95*	6.62
TP-174	100	I.A.	34	10.94*	
TP-176	100	I.A.	34	7.95	5.07

<sup>\*</sup> Massive infection in incision.

organ was considered to be the bone marrow. Although the spleen received a large dose of irradiation, the local damage to this organ must be considered noncritical. The major risk of mortality is extension of the cancer in the 64 per cent of patients who have serosal extension, multiple regional

Table V

HEMATOPOIETIC EFFECT OF 1,000

μc Cr<sup>32</sup>PO<sub>4</sub> Intravenously

3C×10³
3.15
1.75
.80
2.60
2.25
1,20
1.70
1.95
1.00
1

P-50 cachectic 35 days post Cr<sup>32</sup>PO<sub>6</sub>; rat was sacrificed, liver and spleen were reduced in size.

P-49 found dead 40 days post Cr<sup>22</sup>PO4 injection. Autopsy showed liver ½ normal size and spleen 2½ normal size with irregular discoloration. There was blood in the urine and mucoid film coversion interior in the critical state.

ing intestine. P-48 No record of death. nodal metastases or blood vessel invasion.<sup>3</sup> Once overt hepatic metastases are evident, the salvage approaches zero, although certain palliation can be seen.

After the criterion of tumoricidal radiation, the next most important factor is homogeneous irradiation within the liver. External irradiation can approach this level, but is not clinically effective. Chemotherapy, systemic or regional, has been beneficial but not curative. When internal irradiation is given via the hepatic artery, high dose levels are achieved with measurable benefit, but the radiation field within the liver is uneven.

When radioactive particles were injected into the portal vein, the intrahepatic distribution was uneven, due to streaming artifacts. In an attempt to fulfill the above criteria, the present method was chosen, since radiation given into enteric arteries (i.e., superior mesenteric and celiac) will return via the portal venous inflow in mixed venous concentration free of streaming. The laminar flow defects and the residual radiation in the visceral capillary bed should be very low since these particles will traverse that bed easily without embolic effect and there is little reticuloendothelial tissue to

phagocytize the particles in transit. Similar flow characteristics have been shown angiographically. Table 1 confirms the minimal residual radiation in viscera.

Bone marrow irradiation was calculated as 354 rads (Table vi) and Table iv shows that there was no evidence of acute or long term toxicity, and therefore demonstrates that the criterion of absence of systemic toxicity has been met. In addition, no animals died late after irradiation. While the marrow dose is higher than desirable in man, we do not yet have clinical data to show that distribution and bone marrow dose or its hematopoietic effect would be the same in man as in the rat, although close similarity would be expected.

With gross 5 year survival after diagnosis of carcinoma of the colon or rectum less than 40 per cent regardless of treatment, and survival of patients thought to be curable little better, there is room for great improvement in the treatment of these patients suffering from one of the most common fatal malignancies in the United States. Refinements in surgical technique<sup>10</sup> and adjunct chemotherapy5 have improved survival. Our data imply that the clinical application of this method by selective catheterization injection in man would further reduce the incidence of hepatic metastases by possibly half. If demonstrated, such a clinical yield would be dramatic. Our data also imply little morbidity and mortality from this form of therapeutic radiation. We suggest that patients with evidence of poor prognoses, that is, those with extension of the tumor through the muscularis, vein invasion, or regional nodal metastases be treated in this manner.

After adequate clinical experience, it is conceivable that this treatment would be offered to all patients with colon or rectal cancer.

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The authors appreciate the assistance of

TABLE VI
ORGAN DOSE IN RADS

Organ	IA .	IPV	IV
Liver	5,040	5,300	5,040
Spleen	4,550	1,294	7,920
Lungs	181	119	522
Bone Marrow	354	310	926
Stomach	70.9	13.7	10.6
Intestine	84.2	18.7	14.1
Cecum and Rectum	46.5	18.0	5.8
Brain	1.64	1.64	3.60
Ovaries	18.9	7	-
Kidney	28.28	9.29 18.13	26.7 58.00

IA = Intra-arterial.

IPV = Intraportal vein.

IV = Systemic intravenous.

H. V. Bell, M.D., who performed the bone marrow studies.

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### RADIONUCLIDE PERFUSION LYMPHANGIOGRAPHY\*

## AN EXPERIMENTAL TECHNIQUE TO COMPLEMENT THE STANDARD ETHIODOL LYMPHANGIOGRAM

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THE standard Ethiodol lymphangiogram suffers from several acknowledged shortcomings. Among these are:

- 1. Ethiodol is an iodinated fatty acid ester derived from poppyseed oil and is immiscible with body fluids; it may lead to vascular embolism. Studies with I131 labeled Ethiodol show in fact that pulmonary oil emboli occur in every patient.3 Although oil embolism may be asymptomatic and undetected on chest roentgenograms, pulmonary function tests are altered in most patients and serial scintiscans using radionuclide labeled material show substantial persistence of oil in the lungs.4,17 Reported catastrophic complications of Ethiodol oil embolism include pulmonary infarction,4,13,17 cardiovascular collapse,1,4 and cerebral oil embolism.11,13
- 2. Hypersensitivity reactions to the iodine component have been reported; with long-term retention of Ethiodol in lymph nodes, a hypersensitivity reaction could have grave consequences.
- 3. Although lymph nodes opacified with Ethiodol may be demonstrated on roentgenograms with good morphologic detail, the oil may incite granulomata in the lymph nodes which may hinder or prevent a subsequent histologic diagnosis. In addition, false positive and false negative results are

- sometimes obtained because of partial filling or nonopacification of critical lymph nodes; the high viscosity of Ethiodol itself may sometimes contribute to incomplete filling of glands in an otherwise normal lymph chain. Lymph flow patterns, as well as lymphatic obstruction, sometimes may not be well demonstrated with the use of this nonphysiologic, highly viscous contrast medium.
- 4. In specified clinical situations, there may be reluctance to use Ethiodol as a lymphangiographic agent, even when some of the contraindications that have been mentioned do not obtain. For instance, lymphangiography may occasionally be recommended in desperation as a "screening" study for suspected retroperitoneal malignancy, when other studies have failed to elucidate the cause of a fever of unknown origin, of unexplained weight loss or back pain, etc.

In these instances, particularly in young persons, the performance of standard lymphangiography with the potential hazards of Ethiodol (such as hypersensitivity, embolization or both), as well as the possibility of effacing histologic changes in retroperitoneal lymph nodes at a subsequent exploration (see above), may justifiably lead to apprehension.

Other alternative "screening" proce-

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dures, such as intravenous pyelography, inferior venacavography, interstitial (radionuclide) lymphangiography of the lower extremities, or a combination of these can be employed, but their lack of sensitivity leaves much to be desired.

Lymphangiography may also be approached reluctantly in instances where a remediable cause for severe lower extremity lymphedema is being sought; on occasion, a transient or permanent worsening of lymphatic obstruction has been reported following Ethiodol studies in these situations. Traumatic interruption of the thoracic duct, or suspected complete obstruction secondary to tumor or inflammation, which in turn may lead to a chylothorax or chylopericardium, may call for roentgenologic studies to clarify the pathologic anatomy, to establish à diagnosis, or both. Previously, colloidal Au198 has been used to detect thoracic duct leakage.5 A better intralymphatic radionuclide, if identified, should have a shorter physical and biologic half-life, as well as the capability of delineating a pathologic obstruction or lymphatic communication rapidly.

Thoracic duct drainage of lymphocytes is being carried out investigationally in clinical subjects at several institutions for purposes of immunologic suppression, as in intractable rheumatoid disease or threatened transplant rejection, or as a means of removing large numbers of pathologic leukocytes in leukemias. Since the major anatomic lymphatic drainage pathway is occasionally to the right rather than to the left jugular venous angle, a rapid means of establishing the laterality of the terminal thoracic duct could be of considerable assistance to the operating surgeon, before he attempts to introduce a thoracic duct drainage catheter. Whereas establishment of the side of lymphatic drainage in the neck is valuable preoperatively, the demonstration of precise anatomic detail is of lesser importance in this situation.

The existence of the specialized indications listed above, as well as the known hazards and limitations of standard Ethio-

dol lymphangiography, have led us to search for a new and complementary technique to study the pelvic and para-aortic lymph chains. Our aim was to identify a suitable lymphangiographic agent that is miscible with body fluids, similar in viscosity and other physical characteristics to normal lymph fluid, nonallergenic, rapidly absorbed and excreted, and free from the risks of potential pulmonary oil embolism. A further desirable characteristic of any new agent would be its capacity to be delivered to lymph nodes and vessels in high concentration almost immediately following injection, without stimulating subsequent histologic changes in the lymph nodes. This new agent might be used in a "screening" procedure immediately prior to, or in conjunction with, a standard (Ethiodol) lymphangiogram. Since good anatomic detail of lymph nodes and individual lymph vessels is already obtainable from the standard lymphangiogram, our attention has been directed to radionuclides which, through their physicochemical similarities to normal lymph fluid, might give supplementary data about normal and pathologic lymph flow patterns following their direct injection into a peripheral lymph vessel. The premise was that additional sensitivity in detecting a very early abnormality might be achieved with a new agent that demonstrated small aberrations in normal lymph flow patterns, whereas Ethiodol would remain superior in delineating anatomic detail.

In any event, it was hoped that an innocuous agent (here, a radionuclide) might be used for a "screening" examination in those special situations where a standard oil lymphangiogram might be dangerous or otherwise contraindicated (see above). The principal requirement is that the new agent be highly sensitive, if not entirely specific, for detecting early lymphatic abnormalities. If this condition is satisfied, a normal lymphangiogram obtained by the new technique could obviate the necessity for proceeding with an Ethiodol study in risky cases. An "abnormal" screening study re-

sult, on the other hand, while carrying with it the possibility that it is a false positive, might nevertheless justify the necessity of proceeding with an Ethiodol examination, even in the face of a known contraindication (i.e., hypersensitivity or diffuse lung disease). If the new agent was injected directly into a cannulated peripheral lymphatic (as with the standard lymphangiographic study), the decision of whether or not to go ahead with an Ethiodol injection could be made by the radiologist in immediate consultation with the clinician, with the patient still on the examining table and the lymphatic needles already in place.

In an attempt to meet the preceding conditions, a technique was developed (first in experimental subjects and then in a pilot clinical series) employing direct intralymphatic perfusion of technetium 99m labeled human serum albumin;\* this is followed by immediate (scintillation camera) imaging of the perfused lower extremity lymphatics, followed sequentially by the pelvic and para-aortic lymphatic chains, and then the thoracic duct. This new technique, which may be performed alone or as a preliminary examination immediately before standard Ethiodol lymphangiography (see above), will be described and the initial experimental and clinical results presented.

#### MATERIAL AND METHOD

All subjects were examined in a well-hydrated state to promote centripetal lymph flow. In addition, initial experience dictated that no restraints whatever should be applied to the extremities during the bipedal lymphatic radionuclide injections, because even minimal external constriction of the soft tissues sometimes led to apparent, major alterations in the normal pattern of ascent of the radionuclide (see below). In experimental as well as human

subjects, bilateral subcutaneous lymphatic cannulations were first performed in the dorsa of both feet, using standard techniques. Examinations were first carried out in 13 medium-sized dogs under general anesthesia, including 2 animals with naturally occurring, disseminated lymphosarcomas. Following the initial experience in animals, technetium-albumin perfusion lymphangiograms were obtained (in conjunction with subsequent Ethiodol lymphangiograms at the same sitting) in 41 patients, under local anesthesia. Typically, the standard Ethiodol study followed directly after bilateral technetium-albumin injections and scintillation camera imaging in each subject (see above), the radionuclide study requiring approximately 40-60 minutes for completion. The same lymphatic cannulas were used for the injection of both agents (technetium-albumin and Ethiodol), in succession. In the animal studies, 0.5 millicurie of technetium 99m albumin<sup>12,16</sup> in 3-4 ml. of saline was injected simultaneously into both lower extremity lymphatics with a mechanical injector at a rate of approximately 0.2 ml./minute. The attached cannulation tubing was subsequently flushed with saline, using the same injection rate, for several more minutes. In the patients, approximately 1 millicurie of technetium 99m albumin was injected into each lower extremity lymphatic at a similar injection rate. Before injecting the radiopharmaceutical, free (unbound) pertechnetate was removed by filtering the solution through an AG-1-X4 anion exchange resin filter; this was necessitated by the observation that proteinunbound pertechnetate diffused rapidly from the extremity lymphatics into the surrounding soft tissues.

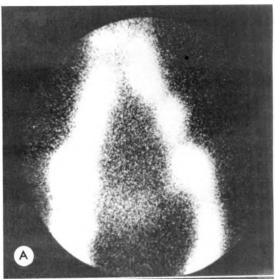
In the experimental subjects as well as in patients, the rapid ascent of the radionuclide was followed by serial Polaroid photographs taken with the scintillation camera (Picker Dynacamera IIb), from the lymphatics of the leg and thigh, through the pelvic and para-aortic chains, and finally into the thoracic duct (when

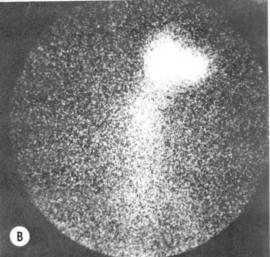
<sup>\*</sup>Observed and calculated total body radiation doses for this radionuclide are trivial. In a very unlikely situation where 60 per cent of an entire injected dose of 1 millicurie was retained in a single inguinal lymph node, the calculated dose to the lymph node itself would be 53.6 rads.

Fig. 1. (A) Anteroposterior pelvic and lower paraaortic view from a normal radionuclide perfusion lymphangiogram (in a woman with Stage 1 carcinoma of the cervix), performed in the 27-28 minute interval after initiation of bilateral lower extremity injections of technetium albumin (see Material and Method). Bilateral femoral, external iliac, common iliac and lower para-aortic lymphatic chains are well shown by this method. Although individual lymph nodes cannot be distinguished, localized enlargements of the lymphatic chains represent groups of normal lymph nodes. It was not unusual to see minor discontinuities in the common iliac chain on either side just distal to the aortic bifurcations, even in normal studies (not demonstrated by this illustration). Another normal finding (demonstrated here) is moderate midline opacification of the bladder by excreted pertechnetate ions. (B) Later in the same normal study (40-41 minutes), the longitudinal course of the thoracic duct is demonstrated with the scintillation camera centered anteriorly over the mediastinum. The duct is shown to enter here into the left jugular angle, with some opacification of left supraclavicular lymph nodes.

visualized). Although completion of the radionuclide perfusion and the subsequent injection to flush the cannulas and attached tubing often occurred simultaneously with completion of the abdominal imaging portion of the procedure (i.e., 20–30 minutes after beginning the nuclide injections), abdominal and chest Polaroid images of the lymph node chains usually were obtained for a full 60 minutes after the initiation of the injection, in order to assess early "washout" of the tracer activity from all lymph node chains. Occasionally, a suspected lymphatic obstruction could be confirmed more convincingly in this manner.

None of the 41 patients experienced untoward discomfort with the technetium-albumin perfusions, but they commonly noticed transitory and mild "tightness" in the calves and thighs, as with standard Ethiodol injections. No hypersensitivity reaction was observed. Criteria for normality (Fig. 1) or abnormality (Fig. 2) on the technetium-albumin perfusion images were similar to those used in interpreting the early or immediate (lymphatic-vascular)





phase of the standard Ethiodol lymphangiogram; obstructions to normal centripetal lymph flow, as well as evidence of circumvention through collateral channels, were sought both on the monitor oscilloscope and on the immediately-obtained Polaroid images from the gamma camera. Grossly enlarged groups of lymph nodes also were easily recognized on the radionuclide perfusion studies, although, as expected, the anatomic detail for individual lymph nodes was relatively poor (see Results). Standard Ethiodol examinations which immediately followed radionuclide perfusion studies were interpreted in the usual fashion.

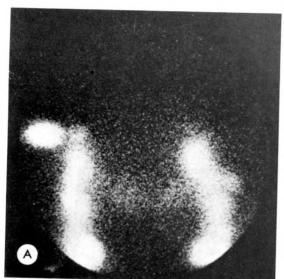


Fig. 2. (A) A 43 year old woman with adenocarcinoma of the cervix and with bilateral common iliac obstructions on radionuclide perfusion study, secondary to metastatic iliac lymph node involvement (confirmed by lymph node histopathology at subsequent surgical exploration).

The largest number of patients studied by both lymphangiogram techniques in this pilot series was in the process of being staged preoperatively for carcinoma of the cervix. This high incidence was the result of a clinical-pathologic investigation that was under way concurrently to evaluate lymphangiography as a preoperative study for cervical cancer, and it does not reflect the usual incidence of malignancies requiring lymphangiography at this institution. The remainder were patients with carcinoma of the vagina, vulva, or ovary, as well as seminoma, prostatic carcinoma, Hodgkin's disease, non-Hodgkin's lymphoma, rheumatoid arthritis (prior to surgical cannulation of the thoracic duct), suspected or known malignancies of the skin or soft tissues of a lower extremity, or fever of unknown origin.

#### RESULTS

Although the initial experience with radionuclide perfusion lymphangiography performed as a prelude to the standard Ethiodol lymphangiogram was obtained in safety of the technique, the present report will focus upon a correlation of the radio-nuclide results with (a) standard lymphangiograms, (b) clinical results and (c) pathologic findings, in 2 animals with naturally occurring lymphosarcoma and in 21 patients (of the 41 patients studied so far with the radionuclide perfusion technique, twenty-one at present have definite pathologic or clinical proof of tumor involvement—or noninvolvement—in the inguinal, external iliac and para-aortic lymphatic chains). Detailed results in additional clinical sases, including those lacking





Fig. 2. (B and C) Corresponding anteroposterior views (2 hours and 24 hours) from Ethiodol lymphangiogram. Obstruction of right common iliac chain with circumvention and lymph node displacement is consistent with tumor involvement (confirmed by biopsy).

pathologic proof at this time, will be presented in a subsequent report as confirmatory data become available.

In the 2 dogs with disseminated lymphosarcomas, enlarged lower extremity (popliteal) lymph nodes, without obstruction, were demonstrated both on the radionuclide and on subsequent Ethiodol lymphangiographic examinations. In an additional normal animal the thoracic duct was very clearly shown within 5 minutes of beginning the lower extremity radionuclide injection. In the light of these results and the experience of obtaining radionuclide lymphangiograms in 11 normal dogs, the decision was made to proceed with a pilot clinical investigation.

Of the 21 proved clinical cases which are the subject of the present analysis, 15 showed complete agreement between the radionuclide study, the standard Ethiodol lymphangiogram, and the clinical/pathologic lymph node examination.\* Of these 15 "concordant" cases, 6 were positive "acrossthe-board" for lymph node involvement by tumor, and 9 were completely negative (Table 1). Of the 6 remaining pathologically proved cases in which the 2 lymphangiographic techniques and the pathologic examinations did not all agree ("non-concordant" cases: Table 11), one with carcinoma of the cervix (Fig. 3) had a positive Ethiodol study, but negative radionuclide and histologically negative lymph node pathologic examinations; 2 cases (one with a fever of unknown origin, and another with persistent adenocarcinoma—probably ovarian—which had already received intensive pelvic irradiation) had a false positive radionuclide study with a negative Ethiodol lymphangiogram and negative histologic lymph node studies; another case with carcinoma of the cervix had a false positive Ethiodol lymphangiogram, together with an equivocally positive radionuclide study

Table I

CASES IN WHICH STANDARD (ETHIODOL) LYMPHANGIOGRAM, RADIONUCLIDE PERFUSION LYMPH-

ANGIOGRAM, AND PATHOLOGIC/CLINICAL LYMPH
NODE EVALUATION WERE IN AGREEMENT
("Concordant Cases")

Diagnosis	All 3 Examinations Positive	All 3 Examinations Negative
Carcinoma of Cervix Carcinoma of Female	I	5
Urethra Adenocarcinoma of		I
Vagina Hodgkin's Disease and non-Hodgkin's	•••••	I
Lymphoma Carcinoma of Colon	4 1	
Total (15 cases)	6	9

and histologically negative lymph nodes; and, finally, 2 cases had false negative Ethiodol lymphangiograms, together with true positive radionuclide studies and positive lymph node histologic examinations. The latter 2 cases—one with metastatic carcinoma of the vulva (Fig. 4) and the other with non-Hodgkin's lymphoma—are potentially of greater interest because they suggest the possibility that the radionuclide study is more sensitive than the standard lymphangiogram in detecting early lymphatic pathology in some cases.

#### DISCUSSION

With respect to the possible use of radionuclide perfusion lymphangiography as a screening study, it is worth noting that no false negative radionuclide studies have been obtained in the first 21 clinical cases with serial radionuclide and standard Ethiodol lymphangiography and with clinical/pathologic confirmation. Indeed in 1 case, a negative radionuclide examination obtained in the face of a "positive" Ethiodol study was subsequently confirmed by the presence of histologically negative lymph nodes at exploration (Fig. 3). In 2 other cases, the radionuclide study identified early lymphatic involvement by tumor,

<sup>\*</sup>These include 2 (1 proved Hodgkin's disease and 1 proved non-Hodgkin's lymphoma) without laparotomy, but with palpable, grossly enlarged peri-aortic lymph nodes; in the remaining 11 cases, all the infradiaphragmatic lymph nodes in question were carefully examined histologically.

TABLE II

CASES IN WHICH STANDARD (ETHIODOL) LYMPHANGIOGRAM, RADIONUCLIDE PERFUSION LYMPHANGIOGRAM, AND PATHOLOGIC/CLINICAL LYMPH NODE EVALUATION WERE NOT IN AGREEMENT

("Non-Concordant Cases")

Case (Diagnosis)	Standard Lymph- angiogram	Radionuclide Study	Pathologic Examination of Lymph Nodes
<ol> <li>M.P. (Carcinoma of Cervix)</li> <li>P.M. (Carcinoma of Cervix)</li> <li>R.F. (Fever of Unknown Origin)</li> <li>B.W. (Adenocarcinoma of Rectal Septum)</li> <li>D.M. (Carcinoma of Vulva)</li> <li>B.L. (Lymphoma)</li> </ol>	Positive Positive Negative Negative Negative Negative Negative	Negative ± Positive Positive Positive Positive	Negative Negative Negative Negative Positive Positive

confirmed subsequently by histologic examination, which was *missed* on the Ethiodol study (Fig. 4). On the other hand, in 2 cases out of the 21, the radionuclide study was positive in a false sense, and the "positive" impression was countered by a nega-

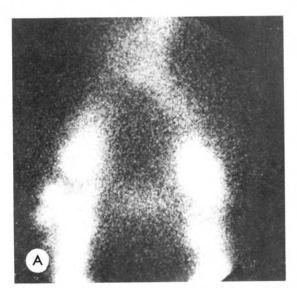


FIG. 3. Case I (M.P.; Table II). (A) A 64 year old woman with squamous cell carcinoma of the cervix (clinically Stage III) had a normal radionuclide perfusion lymphangiogram. Compared to normal study in Figure IA, there does appear to be a minor discontinuity in the right common iliac chain on this anteroposterior scintiphoto, just distal to the aortic bifurcation. However, this finding was commonly observed on normal studies and was therefore disregarded.

tive standard Ethiodol examination which was performed immediately afterwards. However, one of these "false positive" radionuclide studies was performed on a patient who had already received heavy preoperative irradiation to the pelvis, prior to projected pelvic exenteration.

From these preliminary results, therefore, the radionuclide perfusion lymphangiogram seems to fit the requirements for a



Fig. 3. (B) Corresponding Ethiodol study (in the same case), was interpreted as positive for right common iliac tumor involvement (nonfilling of lymph nodes "replaced" by the tumor). However, subsequent pathologic examination of multiple para-aortic and pelvic lymph nodes at surgical exploration revealed no evidence of metastatic tumor (see text).

satisfactory "screening" examination, to be performed prior to standard Ethiodol lymphangiography. If these initial clinical results are borne out in larger numbers of pathologically confirmed cases, it may be possible at times to dispense with the subsequent Ethiodol lymphangiogram, especially in high-risk examinations and in patients with marginal indications for a study (obscure fever), if the initial radionuclide perfusion lymphangiogram proves to be negative. Results of the radionuclide study are available within 30 minutes, and the agent itself (technetium-albumin) is innocuous, without the hazards of hypersensitivity reaction, oil embolism, or distortion of lymph node architecture on later histologic examination. Of possible further importance is suggestive evidence, in 2 of the cases presented above, in which the radionuclide study alone was positive for tumor and was subsequently confirmed by lymph node histologic examination. In

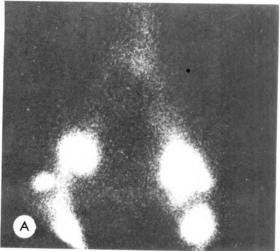


Fig. 4. Case v (D.M.; Table II). (A) A 63 year old woman with epidermoid carcinoma of the vulva had an abnormal radionuclide perfusion lymphangiogram, as evidenced by bilateral enlargement of both external iliac nodal clusters and partial obstruction to proximal lymphatic flow at these levels. As a result, the common iliac and paraaortic chains are poorly visualized (compare with Figure 1A).

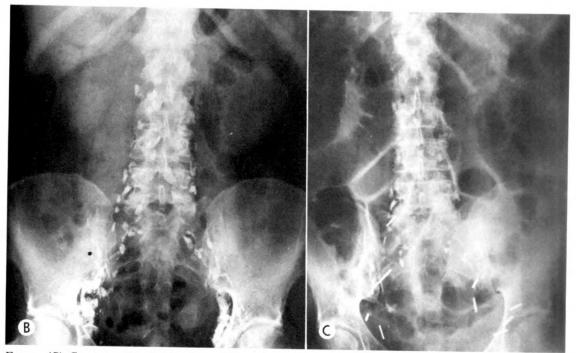


Fig. 4. (B) Corresponding Ethiodol lymphangiogram (same case) was interpreted as normal. Subsequent histopathologic examination of pelvic lymph nodes at surgical exploration revealed metastatic tumor bilaterally (see text). (C) Postoperative roentgenogram, showing lymph node biopsy sites (surgical clips).

these 2 cases, the standard Ethiodol lymphangiogram appeared entirely normal, even in retrospect. Despite the presence of 2 false positive radionuclide studies in our series, if these preliminary findings are borne out in a larger clinical series, a positive radionuclide perfusion result alone may bolster the need in a given case to proceed to a more elaborate staging procedure, including an abdominal-pelvic exploration, regardless of the findings on the standard Ethiodol lymphangiogram.

Finally, it can be stated that further clinical study is imperative to investigate the potential usefulness of radionuclide perfusion lymphangiography in patients in whom the use of Ethiodol may be strongly contraindicated. This includes patients with known hypersensitivity to contrast media or a high risk of oil embolism (as in massive obstructing lymph node masses, mediastinal fibrosis, serious pre-existing lung disease, or a combination of these), in which it is particularly important to preserve lymph node architecture for subsequent histologic examination, and instances in which there may be a substantial risk of exacerbating an existing clinical problem with the Ethiodol (such as severe lymphedema). Specialized indications, such as the investigation of thoracic duct obstruction or of ductal interruption by inflammation, tumor, or trauma, and the lateralization of the main lymphatic channel in the thorax prior to operative thoracic duct drainage procedures, should also be explored further. In all of these instances, the use of oily Ethiodol may be contraindicated or may leave much to be desired. The study of lymph chains by interstitial injection of colloidal Au<sup>198</sup> in the feet<sup>6,7,19</sup> is a slow procedure, is also associated with false positive results,7 and is sometimes difficult to interpret.<sup>14</sup> By contrast, the radionuclide perfusion technique shares the advantage of speed with the standard Ethiodol study, the nuclide being delivered in relatively high concentration both rapidly and directly to the lymphatic structures of greatest interest; in addition,

it appears to have the advantage of being a dynamic and sensitive indicator of normal and pathologic patterns of lymph flow.

#### CONCLUSION

Radionuclide perfusion lymphangiography requires a bipedal cannulation of peripheral lymphatics and may therefore be performed as an examination preliminary to standard Ethiodol lymphangiography.

Experience in 13 dogs, including 2 with disseminated lymphosarcomas, and in a pilot series of 41 patients with various disorders, has shown the ability of this radionuclide technique to provide rapid gross visualization of lymph flow patterns and groups of nodes in the lymphatic chains of the extremities, the lateral pelvic walls, and the periaortic regions. In the 2 animals with generalized lymphosarcoma, and in the 21 patients in whom definitive pathologic or clinical proof of lymph node normality or involvement by tumor is now available, there have been no false negative radionuclide perfusion lymphangiograms.

Standard Éthiodol examinations were performed immediately after the radionuclide study in each case, utilizing the same lymphatic cannulas, and 2 false negative Ethiodol examinations have occurred in the same series. False positive radionuclide lymphangiograms were recorded in 2 cases, one of whom had received intensive radiotherapy to the pelvis for clinicallypresumed lymph node metastases, prior to lymphangiography and subsequent pelvic exploration.

In view of these findings, our preliminary investigations suggest that radionuclide perfusion lymphangiography may prove to be a relatively innocuous precursor or "screening" examination to assess the need for standard Ethiodol lymphangiography, particularly in suspected "highrisk" cases (i.e., known hypersensitivity to contrast materials, severe diffuse lung disease, massive mediastinal tumor or fibrosis, lymphedema, etc.), and in cases where subsequent lymph node histologic examination might be compromised by the occurrence

of oil granulomas resulting from Ethiodol administration.

The radionuclide perfusion examination, if negative, seems to indicate an extremely low likelihood of tumor in the visualized lymphatic chains; if positive, appropriate subsequent diagnostic measures must include Ethiodol lymphangiography (which may be performed immediately, utilizing the pedal lymphatic cannulas which are already in situ), exploratory surgery, or both.

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# MULTICENTRIC RETICULOHISTIOCYTOSIS (LIPOID DERMATO-ARTHRITIS)\*

## AN EROSIVE POLYARTHRITIS WITH DISTINCTIVE CLINICAL, ROENTGENOGRAPHIC AND PATHOLOGIC FEATURES

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IT is our purpose to present a detailed analysis of progressive roentgenographic changes found in complete serial skeletal surveys of 2 men with multicentric reticulohistiocytosis (MR). These changes will be correlated with pathologic findings and compared to roentgenographic features previously reported in MR and to changes characterizing other erosive polyarthritides. It will be shown that the roentgenographic changes of MR are characteristic and a logical extension of the underlying pathology.

Also called lipoid dermatoarthritis, MR is a rare systemic disorder primarily affecting skin and synovium, which results in an erosive, deforming polyarthritis with characteristic and often diagnostic roentgenographic features. The significant features shown in the 2 cases herein reported and in most of the roentgenographically documented cases previously reported are: (1) strikingly bilateral symmetric, sharply circumscribed, rapidly progressive erosions spreading from the margins to the articular surfaces of synovium lined joints, frequently accompanied by increased separation of adjacent bone ends but not subchondral sclerosis; (2) interphalangeal joint predominance; (3) tendency toward early and severe atlanto-axial involvement; (4) disproportion between severity of joint destruction and mildness of symptoms regardless of therapy; (5) absent or minimal periosteal reaction; (6) absent or disproportionately mild osteoporosis despite severe erosive destruction; and (7) prominent, uncalcified nodules of skin, subcutaneous tissue and tendon sheaths. These features parallel and reflect the underlying infiltrative granulomatous synovitis and the mildness of the accompanying inflammatory response.

#### REPORT OF CASES

CASE I. A 31 year old Black man was first evaluated in 1966 at age 24 years following a 4 month history of morning stiffness, periungual and dorsal subcutaneous nodules in the hands, diffuse papular skin rash, and progressive pain and swelling of the hands, wrists, shoulders, knees and ankles. Pertinent physical findings included swelling and tenderness of the wrists, knees, ankles, and interphalangeal joints of the hands, multiple, freely movable subcutaneous nodules on the dorsum of the hands, and a papular rash over the forehead and lateral aspect of the arms. Analysis of synovial fluid from the left knee revealed a poor mucin clot, white blood cell count of 1,800 per ml. (60 per cent lymphocytes and 40 per cent histiocytes), and red blood cell count of 5,600 per ml. Laboratory findings included normal or negative results for complete blood cell count, urinalysis, erythrocyte sedimentation rate, serum uric acid, latex fixation and antinuclear antibody tests. Biopsy of the subcutaneous nodules revealed histologic changes characteristic of MR.

Survey roentgenograms (Fig. 1) disclosed the following abnormalities: marginal erosions of the right third and left fifth metacarpal heads, associated with articular soft tissue swelling, and prominent soft tissue masses on the dorsum of both hands; a 6 mm. atlanto-axial subluxation; small, bilateral erosions of the olecranon and distal humerus; small erosions of the distal end of the left clavicle; and swelling of the

27, 1974.
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knees in the absence of visible erosions. The sacroiliac joints manifested no abnormalities.

Over the next several months, the patient was treated with short courses of colchicine, Indomethecin, Chloroquin and Tetracycline, as well as a prolonged course of acetylsalicylic acid without a significant clinical response. Corticosteroid therapy was prescribed intermittently from 1968 to 1974; during each course arthritic symptoms abated and the subcutaneous nodules decreased in size and number; whenever the dose was decreased to less than 10 mg. per day, articular signs and symptoms worsened.

After 14 months of corticosteroid therapy, roentgenograms (Fig. 2) revealed generalized progression of the erosions: bilaterally symmetrical, well circumscribed, marginal erosions accompanied by soft tissue swelling affected all metacarpophalangeal and interphalangeal joints; nodular soft tissue protuberances overlaid both second proximal interphalangeal joints; several metacarpals were eroded at their bases, as were the right scaphoid and right and left trapezium. Both feet manifested well circumscribed marginal erosions of the metatarsophalangeal joints, most severe at the first and fifth. The proximal interphalangeal joints were similarly eroded. In the left knee, small marginal erosions were disclosed along the posterior aspects of the tibial condyles and the posterosuperior margin of the patella. A large erosion of the sternomanubrial joint was seen in a lateral roentgenogram of the chest. Repeat biopsies with histologic study of subcutaneous nodules and joint synovium reaffirmed the pathologic diagnosis of MR, with no change since the start of corticosteroid therapy.

Re-evaluation in 1973 revealed either negative or normal results for the following laboratory tests: complete blood cell count, erythrocyte sedimentation rate, urinalysis, serum and synovial lipids, serum immunoelectrophoresis, liver function tests, VDRL, latex fixation, antinuclear antibody and complement determinations. The patient currently feels well, but nevertheless has noted slowly progressive, bilateral deformities of the distal interphalangeal joints of his hands without the development of new subcutaneous lesions. Roentgenograms (Fig. 3) revealed continued progression of the erosions in a striking bilateral fashion. The marginal erosions first seen in 1966 had progressed to surface erosions of all the metacarpophalangeal and interphalangeal joints.





Fig. 1. Case 1 following 4 months of arthralgia. (A) The hands reveal erosions of the right third and left fifth metacarpal heads (arrows). (B) A lateral view of the cervical spine discloses atlantoaxial subluxation of 6 mm.

The eroded bone ends had become separated by intra-articular soft tissue. The carpal erosions had enlarged, and new erosions affected the fovea of both distal ulnae. Despite the severity of the erosions, only minimal osteoporosis was present and periosteal new bone was absent. In both hands, the proximal phalanges were deviated in an ulnar direction and the wrists in a radial direction. Mild subluxations affected the interphalangeal joints. In the feet, bilaterally symmetric surface erosions involved virtually all metatarsophalangeal and interphalangeal joints. Both knees manifested progressive enlargement of well-circumscribed marginal erosions. In the shoulders, huge erosions of the

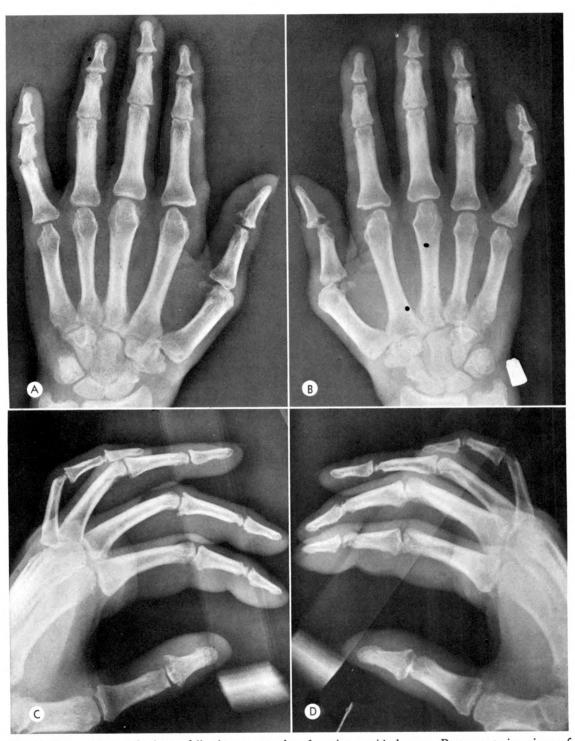


Fig. 2. Case 1, 18 months later, following 14 months of corticosteroid therapy. Posteroanterior views of (A) left and (B) right hands, lateral views of (C) left and (D) right hands.



Fig. 2. (E and F) Anteroposterior views of (E) left and (F) right feet.

Nearly all joints manifest well circumscribed marginal erosions of striking bilateral symmetry. Some joints manifest surface erosions. At this stage the metacarpophalangeal and interphalangeal joints of the hands and the metatarsophalangeal and interphalangeal joints of the feet are affected with equal severity. Subperiosteal new bone is absent and osteoporosis is minimal. Soft tissue nodules are present in peri- and extra-articular regions.

humeral heads were bilaterally symmetrical in severity and site. The distal end of the left clavicle and the inferior margin of both acromia were eroded. The thoracic spine manifested erosions of both costotransverse joints of the ninth thoracic vertebra. In the cervical spine, the 6 mm. atlanto-axial subluxation persisted. Mild erosive changes affected the lower third of the right sacroiliac joint. Despite the presence of large, well-defined erosions of the acetabula, and erosions of the femoral necks that resulted in an apple-core appearance, the femoral heads were relatively spared. Periosteal new bone remained absent and osteoporosis minimal.

Biopsy of a 6 mm. subcutaneous nodule from the left hand (Fig. 7) revealed dense fibrous connective tissue containing capillaries, numerous histiocytes ranging in diameter from 10 to 150 microns, and a sprinkling of lymphocytes. The capillaries manifested a distinct onion-skin appearance, resulting from 3 to 5 layers of spindle-cells resembling fibroblasts arranged concentrically within the capillary walls. This pattern was accentuated by reticulin staining. The remainder of the intercellular tissue

also contained abundant reticulin fibers. The histiocytes contained up to 20 nuclei per cell cross section and cytoplasm containing PAS-positive and lipid-positive droplets. A biopsy of synovium from the left wrist revealed fine papillary synovial folds, the surface of which contained occasional small histiocytes featuring lacy cytoplasm only minimally positive to PAS and lipid stains, and manifesting no more than 2 nuclei per cell.

Case II. A 44 year old Caucasian man had an 8 year history of progressive pain and swelling in both knees, shoulders, wrists, metacarpophalangeal and proximal interphalangeal joints, unrelieved by salicylate therapy. During the past 2 years, an erythematous, papular rash had erupted upon the forehead and right arm, and several small soft tissue nodules had appeared on the dorsum of the hands, in the periungual regions, over the ankles and bridge of the nose. Roentgenograms of the hands (Fig. 4) revealed bilaterally symmetric, well circumscribed marginal erosions of all distal interphalangeal joints and first metacarpophalangeal joints, accom-

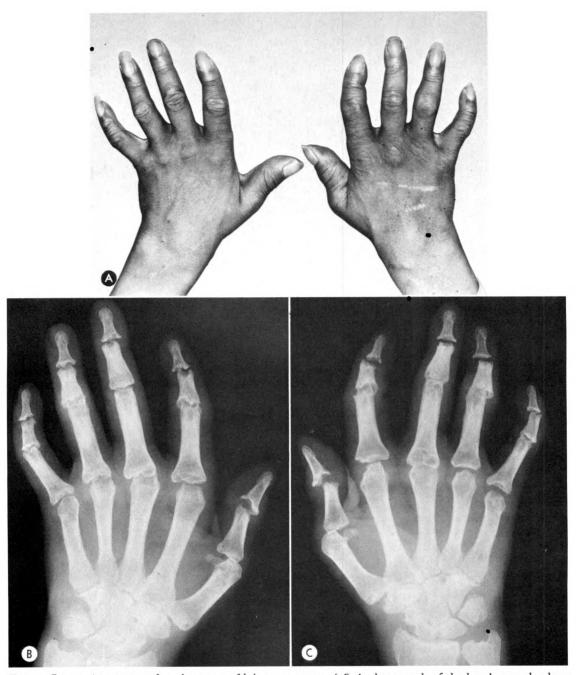


Fig. 3. Case I. At 7 years after the onset of joint symptoms. (A) A photograph of the hands reveals ulnar drift of the fingers and deformed interphalangeal joints. Posteroanterior views of (B) left and (C) right hands reveal that the erosions have progressed in severity, are strikingly bilaterally symmetrical and well circumscribed. All joints are severely eroded, but destruction of subchondral bone predominates at the interphalangeal joints. The adjacent destroyed bone ends have become increasingly separated. Subperios tal new bone is absent and osteoporosis is disproportionately mild.



Fig. 3. (D and E) Erosions of equal severity are seen in anteroposterior views of (D) left and (E) right feet.

panied by soft tissue swelling without osteoporosis or periosteal new bone. Similar erosions were present at the second right metacarpophalangeal joint. Biopsies of affected skin and a finger nodule confirmed the diagnosis of MR.

Despite therapy with salicylates and Indomethecin, pain, swelling and limitation of motion progressed, and pain began in the neck and lower back. One and one-half years later, the hand erosions had enlarged (Fig. 5) and a new erosion was seen at the base of the right first metacarpal. All metacarpophalangeal joints were swollen and painful. Mild bilateral deformities were present at the distal interpha-

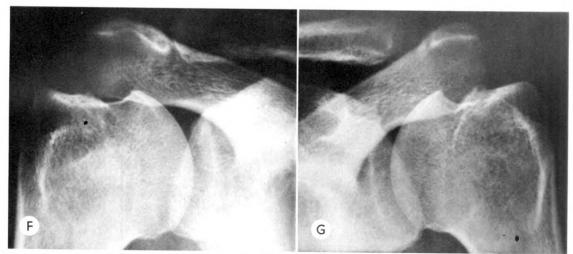


Fig. 3. (F and G) The (F) right and (G) left shoulders manifest huge, bilaterally symmetrical erosions of the humeral heads and inferior surface of the acromia, and destruction of the left acromical avicular joint.





Fig. 3. (H-J) (H) An anteroposterior view of the pelvis discloses an erosion (arrow) along the iliac surface of the inferior part of the right sacroiliac joint. Huge erosions affect the acetabula. Lateral views of (I) right and (J) left hips disclose erosions of the femoral necks, causing them to resemble apple-cores. The femoral heads are relatively spared and the distance between the adjacent subchondral bone margins is maintained despite the severe acetabular erosions seen in H.

langeal joints of the index and little fingers. Roentgenograms of the feet and cervical spine revealed no abnormality, but small erosions without adjacent sclerosis were seen along the lower thirds of both sacroiliac joints. Roentgenograms of the knees revealed soft tissue swelling in the absence of erosions. None of the roentgenograms disclosed periosteal new bone or significant osteoporosis.

Physical examination revealed a well-developed, muscular man with multiple, small, freely movable, nontender subcutaneous nodules over the bridge of the nose and dorsum of the hands.

Both elbows were tender and warm, and both knees exhibited warmth, pain on motion, effusion, crepitation and 60 degree flexion contractures. Subsequently, the patient was treated for 18 months with Cytoxan during which time significant relief of joint symptoms was accompanied by disappearance of several cutaneous and subcutaneous nodules, and no roentgenographic progression of erosions.

Biopsy of a joint in the left hand before Cytoxan therapy (Fig. 8), revealed a moderately cellular infiltrate along a flattened synovial surface. A striking proliferation of histio-

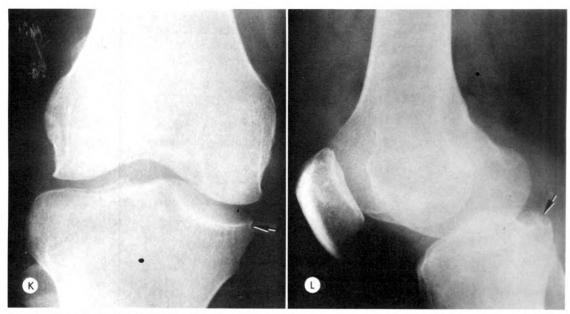


Fig. 3. (K and L) An anter-posterior view of the (K) right knee reveals a well circumscribed marginal erosion (arrow). A lateral view of the (L) right knee discloses a well circumscribed erosion along the posterior margin of the tibial plateau (arrow). Bilaterally symmetrical changes were present in the contralateral knee.

cytes predominated near the synovial surface. The histiocytes ranged in diameter from 10 to 40 microns, and contained I to 4 oval, round, or slightly lobulated nuclei, and cytoplasm manifesting fine granules of PAS-positive and lipidpositive material. The surface cells had basophilic cytoplasm while those more deeply situated had eosinophilic cytoplasm. Occasional lymphocytes and rare polymorphonuclear neutrophils were present. The subsynovial tissue was edematous and contained numerous capillaries, moderate numbers of hemosiderin laden macrophages (signifying previous hemarthroses) and histiocytes less numerous than those within the synovium. Microscopic examination of a 3 mm. skin nodule over the left knee revealed dense, fibrous connective tissue and abundant capillaries with an onion-skin appearance. Histiocytes identical to those within the synovium were noted. On light polarization, spaces appearing between the collagen fibers represented foci of proliferating histiocytes. The collagen fibers were only minimally disrupted, and histiocytes neither surrounded, engulfed nor contained collagen fibers.

Following several additional months of Cytoxan therapy, roentgenograms of the hands and sacroiliac joints revealed no progression of the erosions. Roentgenograms of the feet,

shoulders, elbows, ankles, hips and entire spine revealed no abnormality except for minimal degenerative changes in the spine. The knees remained swollen in the absence of erosions.



Fig. 3. (M) An anteroposterior view of the thoracic spine reveals erosions of the costotransverse joints of the 9th thoracic vertebra.





Fig. 4. Case II. After 8 years of pain and swelling of multiple joints, and 2 years following the onset of skin nodules. (A) Photograph of the hands showing small nodules on the dorsum of the fingers and in the periungual regions. (B) Posteroanterior view of the hands. Well circumscribed marginal erosions affect all distal interphalangeal joints, first metacarpophalangeal joints and the base of the right second metacarpal. A mild flexion deformity affects the distal interphalangeal joint of the right little finger.

#### DISCUSSION

Although the designation "multicentric reticulohistiocytosis" has come into general use, at least 12 synonyms pervade published reports: lipoid dermatoarthritis, 1,4,6,10,14,19 giant cell histiocytomatosis, giant cell histiocytosis, 2 reticulohistiocytic granuloma, 13,16 giant cell reticulohistiocytosis, 10 reticulohistiocytoma, 1,16–18 lipoid rheumatism, normocholesterolemic xanthomatosis, nondiabetic cutaneous xanthomatosis, 20 reticulohistiocytosis, 19 giant cell reticulohistiocytoma and lipoidosis simulating rheumatoid arthritis. 8,9 A recent survey of the literature by Barrow and Holubar uncovered 33 documented cases of MR and 95

related articles. Reports of 3 additional cases have since been published, 5,6,7,15 I of these cases being reported twice to emphasize clinical and roentgenographic features.

#### CLINICAL FEATURES

The onset of MR may occur at any time between adolescence and senescence. The mean age at onset is 43 years. Females are affected more commonly than males in a ratio of 2:1. Caucasians have comprised 85 per cent of the 38 published cases, including 1 of the 2 cases herein reported. The remaining cases include 3 Black Americans (1 herein reported), a Japanese American and an American Indian. No substantive evidence of familial predisposition for the disorder has been established.

Clinical manifestations begin insidiously. In the majority of cases, polyarthritis precedes the nodular cutaneous eruptions by an average of 3 years, a fact that emphasizes the importance of early roentgenologic recognition. One of the clinical hallmarks of MR is rapid progression of joint involvement. Although the disease tends to wax and wane, it frequently evolves into an incapacitating and deforming arthritis, with the interphalangeal joints being the predominant sites of hand involvement. In a third of the cases, destruction of articular cartilage and underlying bone is so extreme as to result in "arthritis mutilans" (Fig. 6). Cutaneous and subcutaneous nodules predominate in the vicinity of the ears, bridge of nose, scalp, dorsum of hands and nail beds. The nodules repeatedly appear, enlarge and often regress; however, new crops of nodules arise as older ones stabilize or disappear. Finally, after several years, the arthritis and nodules may become quiescent. At this end-stage of disease, the patient is frequently left with crippling deformities of the hands and a disfigured "leonine facies."

One report of MR with autopsy findings<sup>19</sup> described typical nodules of the skin, subcutaneous tissue, laryngeal mucosa, bone, voluntary muscles, bronchial lymph nodes







Fig. 5. Case II. Eighteen months later. (A and B) Posteroanterior views of the hands disclose marginal erosions that have progressed to surface erosions with resultant bilateral deformity of the interphalangeal joints of the index and little fingers. A new erosion is seen at the base of the right first metacarpal. All metacarpophalangeal and interphalangeal joints are swollen. (C) An oblique view of the thumb and index finger of the right hand shows well circumscribed erosions (arrows).

and endocardium. In a recently published case report<sup>6</sup> MR has been histologically documented not only in the skin, subcutaneous tissue, and synovium of joints and tendon sheaths, but also in the perirenal fat and stomach. This histologic evidence implies that, at least in some patients, MR is a systemic disorder.

#### PATHOLOGIC FEATURES

The skin lesions of MR are characterized by well circumscribed, unencapsulated, nodular infiltrates, each measuring a few millimeters to a few centimeters in diameter, localized between bundles of dermal collagen. The nodules may occupy part of the dermis, may extend throughout its entire thickness to encroach upon the subcutaneous fat, or may be entirely subcutaneous in location (Fig. 7). The histologic hallmark of MR is the presence of multinucleate, lipid-laden histiocytes sometimes resembling foreign body type giant cells. The bizarre nuclei within the histiocytes may be peripherally or centrally aligned.

Up to 20 nuclei may be present in each histiocyte. The nuclei are round, oval or lobulated, bounded by a distinct membrane and contain I or 2 prominent nucleoli. The cytoplasm is eosinophilic, may exhibit either a finely granular or foamy appearance, or may contain tiny vacuoles. Mononuclear histiocytes containing finely granular eosinophilic cytoplasm are present in large quantities. The dermal connective tissue is well vascularized. Lymphocytes may form discrete perivascular cuffs around numerous dilated capillaries and, in early lesions, may result in dense lymphocytic infiltrates. In both cases herein reported, the capillaries manifested an onion-skin appearance, resulting from concentric layering of spindle cells resembling fibroblasts within the capillary walls. This feature is noteworthy, being found in no other inflammatory polyarthritis except systemic lupus erythematosus, where onion-skinning is seen in the splenic arterioles.

The synovial lesions of MR (Fig. 8) are similar histologically to those of the skin.

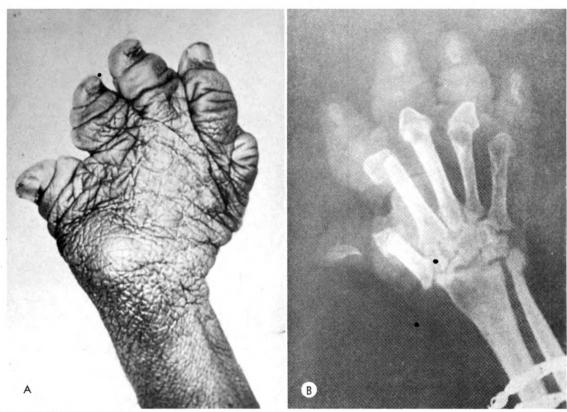


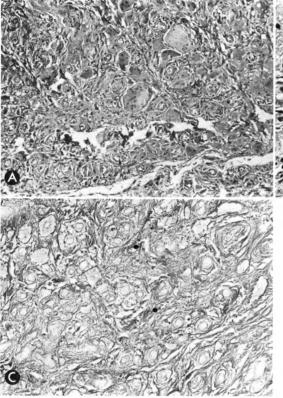
Fig. 6. End-stage arthritis mutilans resulting from multicentric reticulohistic ytosis. (A) A photograph of an "accordian hand" of another patient with MR shows shortened fingers with severe redundancy or wrinkling of the skin, characteristic of late MR. (B) A comparable roentgenogram reveals loss of underlying bone scaffolding. Many folds of skin are present. (Courtesy of W. Martel, M.D. and the publishers of Radiology. (14)

Histiocytes proliferate within an edematous and highly vascular stroma, and are seen in greatest numbers near the synovial surface.

The synovitis of MR must be distinguished pathologically from that of florid rheumatoid arthritis which may rarely be associated with giant cells<sup>11</sup> (Fig. 9). The giant cells of rheumatoid synovitis like those of MR may feature multiple peripherally aligned nuclei, but differ from those of MR in that their cytoplasm is homogeneous rather than foamy or granular. Moreover, florid rheumatoid synovitis manifests more severe villous hyperplasia and a greater abundance of lymphocytes and plasma cells.

ROENTGENOGRAPHIC FEATURES
Although striking roentgenographic

changes are frequently associated with MR, less than a third of published reports contained roentgenograms, 1,3,4,5,8,10,13,14,16,18,19 and scant attention has been given to detailed roentgenologic analysis.4,13,14,16,18,19 In the previously reported cases the interphalangeal joints of the hands were the most frequent sites of involvement, being affected in 77 per cent of cases. In threefourths of the cases with roentgenograms of the hands, marginal erosions of the interphalangeal joints eventually progressed to extensive destruction of the articular surface cartilage and underlying bone. Accompanying this destruction were increased separation of the eroded bone ends by the edematous, thickened synovium, and soft tissue swelling of striking severity. Multinodularity of the skin, subcutaneous tissue and tendon sheaths in the hands, wrists and



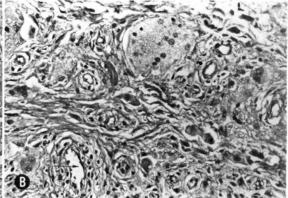


Fig. 7. Case I. Histology of a subcutaneous nodule in the left hand. (A) The nodule is composed of dense, fibrous connective tissue, large histiocytes containing multiple small, round nuclei and granular cytoplasm, and numerous capillaries surrounded by concentric onion-skin layers of fibrous tissue between which are lymphocytes (arrows). (H and E, X125.) (B) Higher magnification reveals that the histiocytes contain distinctive foamy, almost lacy cytoplasm (upper center) and concentrically layered capillaries (arrow) infiltrated by lymphocytes. (H and E, ×350.) (C) Reticulin staining clearly reveals the pattern of the multiple layered capillary walls. (X125.)

upper limbs was reflected roentgenographically in large and small soft tissue masses that were neither increased in density nor calcified.

The roentgenographic changes in the 2 cases herein reported are characteristic of MR. The erosions ultimately predominated in the interphalangeal joints of the hands, and were marginal, well circumscribed, and strikingly bilaterally symmetric in distribution and extent. In the first and more advanced of our 2 cases, the marginal erosions in the hands and feet rapidly progressed to symmetric surface erosions of almost all of the synovium lined joints. The shoulders, hips and sternomanubrial joints manifested bilateral erosions as severe as those in the hands and feet. Atlantoaxial subluxation was present virtually from the onset of symptoms. The sharp margins of the erosions, disproportionate mildness of the accompanying osteoporosis, and absence of periosteal new bone reflected the mildness of the inflammatory response and resultant lack of repair by the underlying bone.

#### ROENTGENOLOGIC DIFFERENTIAL DIAGNOSIS

Since in MR arthritis often precedes cutaneous manifestations, astute roentgenologic analysis may play a key role in early diagnosis. Other erosive polyarthritides with early or predominant peripheral joint manifestations are psoriatic arthritis, Reiter's disease, rheumatoid arthritis, erosive osteoarthritis and gout. With the sole exception of erosive osteoarthritis, in which the erosions are central from their inception, the erosive polyarthritides including MR are characterized by marginal erosions which progress to surface erosions. However, the character and distribution of the erosions and the presence or absence of concomitant periosteal reaction and osteoporosis vary from one form of arthritis to the next. These variations serve as dis-

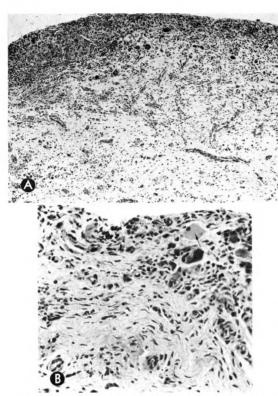


Fig. 8. Case II. Histology of synovium taken from a joint in the left hand. (A) The synovial surface is flat and hypercellular. The round, dark masses seen along the upper portion of the field represent large histiocytes. The deeper synovial layers are edematous, hypervascular and contain hemosiderin filled macrophages. (H and E, ×50.) (B) Higher magnification discloses a large granular histiocyte (arrow) with a small, round, eccentric nucleus. (H and E, ×300.)

tinguishing clues to the diagnosis.

Although arthritis mutilans is the non-specific end-stage of any inflammatory polyarthritis, no polyarthritis is as rapidly destructive as MR. Many folds of skin may be present because of loss in length of the underlying bone scaffolding (Fig. 6).

Psoriatic Arthritis: Because classical psoriatic arthritis predominates in the distal interphalangeal joints, this erosive polyarthritis is most likely to be confused with MR. Many differing features enable the 2 disorders to be distinguished: whereas the erosions of MR are striking in their bilateral symmetry, are well marginated, and not associated with periostitis, the erosions of psoriatic arthritis tend to be bilaterally

asymmetric, manifest ill defined or fuzzy margins, and are characteristically associated with periosteal new bone that may be florid. Interphalangeal ankylosis in the hands or feet occurs in 15 per cent of patients with psoriatic arthritis, but has not been reported in MR. Although subungual and periungual nodules occur in MR, thickened and deformed nails, frequently seen in roentgenograms of the hands and feet in psoriasis, are not found in MR.

Reiter's Disease: The erosions of Reiter's disease tend to be bilaterally asymmetric and predominate in the lower limbs, particularly the feet, and sacroiliac joints. The appearance of the erosions and periosteal reaction may be identical to that seen in psoriatic arthritis. Many of the features distinguishing psoriatic arthritis from MR are, therefore, the same that distinguish Reiter's disease from MR.

Rheumatoid Arthritis of Adult Onset: Whereas MR involves the interphalangeal joints most severely, rheumatoid arthritis tends to affect most severely the metacarpophalangeal and metatarsophalangeal joints. As in MR, the erosions tend to be

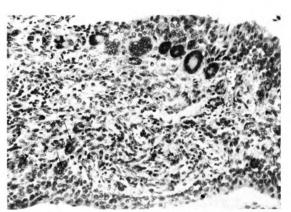


Fig. 9. Rheumatoid synovitis with giant cells. The giant cells probably arise by syncytial fusion of synovial histiocytes (arrows), and then migrate into the deeper tissues. The nuclei are abundant, forming rosette-like structures. The cytoplasm of the giant cells in rheumatoid synovitis is homogeneous rather than granular or vacuolar as typifies the histiocytes of MR. More extensive lymphocytic and plasma cell infiltrates are present in rheumatoid synovitis than in MR. (H and E, ×250.)

bilaterally symmetrical and incite little or no periosteal reaction. Unlike active MR, in which osteoporosis is absent or minimal, severe osteoporosis is characteristic of rheumatoid arthritis and may be one of its earliest manifestations. Atlanto-axial subluxation is common to both rheumatoid arthritis and MR.

Gout: The sharp margins of erosions, paucity of associated periosteal new bone, and relative lack of osteoporosis even in the face of severe erosions are features common to gout and MR. In contradistinction to MR, the distribution of erosions in gout tends to be haphazard and bilaterally asymmetric and their progression is very slow. Preservation of articular cartilage in the presence of extensive focal erosions is a characteristic feature of gout that is absent in MR; in MR the surface articular cartilage and underlying bone are destroyed rapidly and relatively early in the course of the disease. In cases of inadequately treated gout, tophi of long duration may be slightly and sometimes strikingly increased in roentgenographic density as a result of calcium urate deposition, whereas the soft tissue nodules of MR do not manifest calcification or increased density. Long-standing, inadequately treated gout may feature huge erosions with tophi bounded by prominent overhanging projections of subperiosteal new bone which extend far beyond the original cortical surface. This feature is specific for gout and does not occur in MR.

#### SUMMARY

Detailed analysis of the progressive roentgenographic changes found in complete serial skeletal surveys of 2 men with multicentric reticulohistiocytosis (MR) have been correlated with pathologic findings and compared to features previously reported. The lesions of MR predominate in skin and synovium and result in the following characteristic features: (I) sharply circumscribed, rapidly progressive, strikingly bilaterally symmetric erosions spreading from joint margins to articular sur-

faces; (2) interphalangeal joint predominance; (3) early and severe atlanto-axial involvement; (4) disproportion between severity of joint destruction and mildness of symptoms; (5) absent or minimal periosteal reaction; (6) absent or disproportionately mild osteoporosis compared to the severity of erosions; and (7) prominent, uncalcified soft tissue nodules. Since arthritis often precedes cutaneous manifestations, careful roentgenologic evaluation may play a key role in early diagnosis.

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## CLINICAL APPRAISAL OF A NEW LYOPHILIZED Tc99m STANNOUS PYROPHOSPHATE KIT FOR SKELETAL IMAGING\*

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THE stannous chelate of pyrophosphate (SnPyP) complexed with Tc99m is a stable and convenient agent which has been reported to provide excellent skeletal images in clinical trials.4,6,7 Being a specific linear dimer, it offers more consistency in labeling characteristics and bone localization than the polyphosphates of variable chain lengths. In addition, blood clearance and bone uptake are more rapid, and boneto-background ratios have been proven to be higher.8 Recent work suggests that Tc99m stannous polyphosphate is hydrolyzed in vivo to pyrophosphate which may in fact be the active compound localized in bone.2

The accumulation of a bone-seeking radiopharmaceutical accomplishes 2 functions: (1) the definition of normal bone structure; and (2) delineation of bone lesions in contrast to normal bone. The initial clinical trials of Tc99m SnPyP have established its capacity to produce high quality images of normal bone. As a result, it is possible in some cases to detect skeletal abnormalities which do not concentrate the radionuclide and appear as negative defects, as reported recently with polyphosphates.3,5 However, the high concentration in normal bone is a potential disadvantage in the detection of the more common lesions which are associated with increased radioactivity. The final determinant of success for any new bone imaging radiopharmaceutical is the degree to which it concentrates in bone lesions relative to background and normal bone. Although labeled phosphates have proven ability in defining the normal skeleton, their accuracy in detecting lesions has not yet been documented.

The purpose of this investigation was to evaluate Tc<sup>99m</sup> SnPyP in relation to a bone imaging agent with a known level of accuracy. Strontium 85 chloride was selected for the comparison because it has been observed in our experience and others, that despite some logistic disadvantages, this radionuclide when properly used results in the highest lesion-to-background ratio of any of the commonly used radiopharmaceuticals.<sup>1,9</sup>

#### MATERIAL AND METHOD

Prior to clinical evaluation of the Tc99m SnPyP kit, extensive pharmacologic and toxicologic studies were performed in animals. Tissue distribution was measured in organ samples from rabbits injected with 33 µc/kg. containing 0.2 mg./kg. of SnPyP. An average of 55 per cent of the injected dose was accumulated in bone within I hour, with 45 per cent still detectable at 36 hours. The primary mode of excretion was in the urine with 32 per cent of the injected dose appearing at I hour and 50 per cent at 36 hours. Remaining soft tissue concentration was minimal. In acute and subacute toxicity studies performed in mice, rats, rabbits, and dogs using 10 to 100 times the anticipated maximum human equivalent dose of 0.2 mg./kg., no signs of any gross or microscopic toxic effects were detected. In consideration of the potential chelation of ionized serum calcium by the SnPyP, serial bipolar lead II electrocardiograms were recorded in anesthetized dogs before, during, and after the administration of 5 to 50 times the maximum anticipated adult dose. No abnormalities including prolongation of the Q-T interval were observed.8

The kit used in this study was supplied

<sup>\*</sup> From the Baylor College of Medicine and St. Luke's Episcopal-Texas Children's Hospitals, Houston, Texas.

	Sr <sup>85</sup>	Tc99mSnPyP
A. Detection of Abnormalities	;	
Normal scans	4	6
Abnormal scans	13	14
Questionable scans	3	o
(2 equivocally positive)	-	
(1 equivocally negative)		
Total abnormal scan areas	32	50
3. Image Quality		
Definition of bone structure		
Good	0	79 per cent
Fair or poor	100 per cent	21 per cent
Non-target activity	5/20 (25 per cent)	16/20 (80 per cent)
Interference with interpretation	3/20 (15 per cent)	О .
Lesion-to-bone contrast		
Good	62 per cent	<ul><li>85 per cent</li></ul>
Fair or poor	38 per cent	15 per cent

as a vial containing 15.4 mg. lyophilized stannous pyrophosphate, sterile and pyrogen-free, in a nitrogen gas atmosphere.\* Labeling is accomplished by adding 10 to 100 mc of pertechnetate in a volume of 1 to 10 ml., and allowing the solution to stand for 5 minutes at room temperature. Labeling efficiency was determined by descending chromatography using Whatman No. 3MM paper developed in a solvent mixture of 85 per cent methanol and 15 per cent aqueous NH<sub>4</sub>OH (10 per cent).

The first 30 patients of more than 400 imaged to date were monitored before and after injection of 10 mc (2 to 10 mg. SnPyP) for changes in neurologic or vital signs. Fifteen of these were further evaluated by the following tests before and 24 to 48 hours following injection: complete blood cell count, alkaline phosphatase, SGPT, total bilirubin, BUN, creatinine, and routine urinalysis. Scintillation camera imaging was performed at 3 hours postinjection in multiple anterior and posterior views covering the entire skeleton.

To investigate comparable clinical efficacy, 20 patients were scanned with both Sr<sup>85</sup> and Tc<sup>99m</sup> SnPyP. These patients

\* TechneScan  $^{\rm TM} P_{\rm Y} P^{\rm TM}$  (stannous pyrophosphate)  $\mu.$  Mallinckrodt, Inc., St. Louis.

were selected on the basis of 2 criteria: (1) positive Tc<sup>99m</sup> SnPyP scan, or (2) negative Tc<sup>99m</sup> SnPyP scan, but a high suspicion of bone disease from other clinical findings. Strontium scans were performed with the rectilinear scanner from 4 to 7 days following the injection of 100  $\mu$ c of Sr<sup>85</sup>. The strontium and pyrophosphate scans were interpreted independently and graded for over-all image quality (definition of bone structure, interference from bladder, liver, or colon, number and location of abnormalities, and lesion-to-bone contrast).

#### RESULTS

In all Tc<sup>99m</sup> SnPyP preparations tested, radiochromatography revealed greater than 99 per cent labeling efficiency with no evidence of saturation of binding capacity for SnPyP when up to 100 mc of Tc<sup>99m</sup> was added to the kit.

The administration of Tc<sup>99th</sup> SnPyP to more than 400 patients has produced no adverse effects. Vital and neurologic signs remained essentially unchanged after injection, and the biochemical blood and urine testing in the initial 15 patients was negative.

In the comparison of pyrophosphate and strontium scans, 14 of the 20 patients had

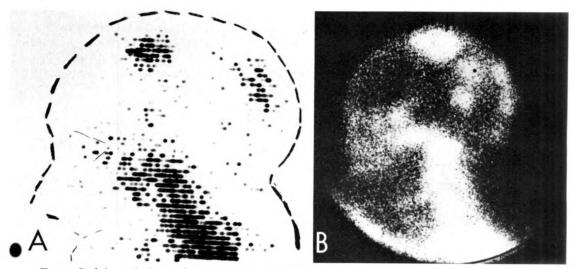


Fig. 1. Left lateral views of skull in a 76 year old male with metastatic carcinoma of prostate.

(A) Sr<sup>85</sup> (without contrast enhancement), and (B) Tc<sup>99m</sup>SnPyP.

abnormal Tc<sup>99m</sup> SnPyP scans. The corresponding Sr<sup>85</sup> scans were interpreted as definitely abnormal in 13 of these patients and questionable in one due to gastrointestinal retention of activity overlying bone (Table 1, A). Similar non-target activity was visualized in 2 other Sr<sup>85</sup> scans in spite of a delay of 4 to 7 days between injection and scanning in the majority of patients. In contrast, the bladder visualiza-

tion, which occurred in most of the Tc<sup>99m</sup> SnPyP scans, did not interfere with the interpretation in any case (Table 1, B). A total of 50 abnormal areas was noted in the Tc<sup>99m</sup> SnPyP scans and 32 in the Sr<sup>85</sup> scans. Figures 1 and 2 represent images in which the abnormalities were greater in number and better delineated with Tc<sup>99m</sup> SnPyP than with Sr<sup>85</sup>. Definition of bone structure was rated good in 79 per cent of the Tc<sup>99m</sup>

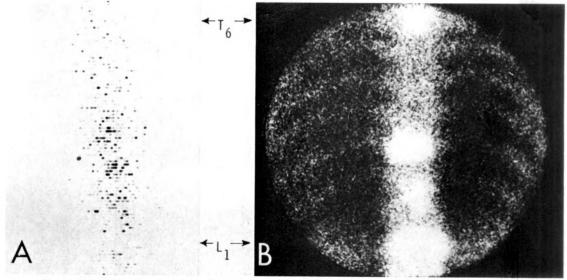
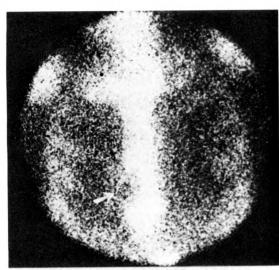


Fig. 2. Posterior views of spine in a 48 year old male with metastatic carcinoma of prostate.

(A) Sr<sup>85</sup> (without contrast enhancement), and (B) Tc<sup>99m</sup>SnPyP.



ANTERIOR

Fig. 3. Anterior view of sternum in a 60 year old male with metastatic carcinoma of lung showing bone lesion with decreased Tc99mSnPyP uptake (arrow).

SnPyP scans, but in none of the Sr<sup>85</sup> scans, while lesion-to-bone contrast was good in 85 per cent of the Tc<sup>99m</sup> SnPyP scans and 62 per cent of the Sr<sup>85</sup> scans. In addition, I patient had a sternal lesion thought to be metastatic carcinoma of the lung which resulted in diminished radioactivity on the scan (Fig. 3).

#### CONCLUSIONS

This investigation suggests that Tc99m SnPyP is probably more effective than Sr<sup>85</sup> in detecting lesions, and, in addition, it offers several significant advantages over previously used agents. In addition to the obvious benefits of Tc99m labeling with a resulting high photon yield, reduced radiation dose, and appropriate gamma energy for the scintillation camera, the consistency of its labeling characteristics and bone localization is a definite improvement over polyphosphates. These features permit bone scanning to be used as a routine screening procedure. With Tc99m SnPyP there is no interference from either excretion into the gastrointestinal tract which is a problem with Sr85, or collection of activity in the liver as seen with F18. With the high degree of normal bone localization which apparently does not decrease lesion-to-normal bone contrast, the identification of areas having decreased activity is possible, whereas such lesions cannot be readily discerned with Sr<sup>85</sup>. The new diphosphonate agent may be very similar to pyrophosphate in imaging characteristics, but this remains to be proved by comparative clinical study.

Tc<sup>99m</sup> labeled stannous pyrophosphate from a new lyophilized kit is easy to prepare and produces bone images of excellent quality. No toxic effects were detected in animals receiving up to 100 times the human equivalent dose, and no adverse reactions have been observed in more than 400 patients who have received an imaging dose of 10 mc (2 to 10 mg. SnPyP).

In a comparison with Sr<sup>85</sup> in 20 patients, Tc<sup>99m</sup> SnPyP was interpreted as normal in 6 cases and abnormal in 14, while Sr<sup>85</sup> produced normal scans in 4 patients, abnormal scans in 13, and questionable results in 3 due to interference from gastrointestinal activity overlying bone. In addition, lesion-to-bone contrast was better using Tc<sup>99m</sup> SnPyP and a greater number of abnormalities were detected than with Sr<sup>85</sup>.

Due to the rapid localization in bone and the lower radiation dose to the patient as compared with Sr<sup>85</sup>, agents such as Tc<sup>99m</sup> SnPyP should render total body bone scanning a routine procedure in nuclear medicine facilities.

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## CARCINOEMBRYONIC ANTIGEN (CEÅ) MONITORING IN THE MANAGEMENT OF RADIOTHERAPEUTIC AND CHEMOTHERAPEUTIC PATIENTS\*

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GOLD and Freedman in 19658 reported a new antigen which they found in human colonic cancers and human fetal colonic tissue. This antigen was named carcinoembryonic antigen or CEA. Since then, many papers have been published on the application of this test in human cancers, not only for colonic, but in other cancers as well. This antigen was originally thought to be entodermally derived, tumor specific, and diagnostic for colon carcinoma.<sup>7</sup>

The clinical usefulness of CEA after numerous studies is currently contradictory and unclear.<sup>2-7,10,11,13,14-21</sup> In the beginning, it was thought that the test would be useful in screening of the otherwise undiagnosed patients with colon cancers,7 but such has not been the case.4 The Hansen radioimmunoassay technique can detect nanogram (10-9 gram) quantities in plasma which should represent rather small tumors, but the percentage of false positives and negatives is quite high. On the other hand, it may be of value in certain high risk cancer groups, e.g., breast mastopathies and polyposis of the colon.7 However, CEA is not a tumor specific antigen. CEA is more likely a tumor associated group of antigens, one of which may be specific for entodermally derived tissues, or, e.g., from noncancerous, injured cells of lung, kidney, gastrointestinal tract, and liver.<sup>13</sup> Elevated CEA levels have also been reported in smokers, 18 patients taking vitamin pills, and patients with various illnesses such as inflammatory bowel disease and liver disease.21

The objective in the planning and carry-

ing out of this study was to clarify and extend the interpretation and application of a currently available immunologic test to the monitoring and management of the patient undergoing radiotherapy or chemotherapy. To carry out this study 2 groups of patients were selected. One group of 122 patients was selected for study from a Radiation Oncology Clinic. A separate group of 52 patients was selected from those treated in a Cancer Chemotherapy Clinic using accepted protocols of cancer chemotherapeutic agents. The clinical and CEA responses are compared in this report in an effort to compare the usefulness of this assay in 2 groups of patients with cancer, undergoing antitumor therapy of 2 different types.

#### MATERIAL AND METHOD

The method used is essentially that developed by Hansen et al. and described in detail by them and others 12 for CEA. Basically, a standard radioimmunoassay using I126 labeled monospecific goat anti-CEA antibody was carried out. A sample of plasma was obtained from the patient using EDTA as an anticoagulant and was assayed for CEA. Low plasma levels may be detectable, but the test was not considered positive unless the level was greater than 2.5 nanograms/ml.

Patient population studied and sampling pattern. The patient population studies were all drawn from the Radiation Medicine Clinic and Surgical Oncology Clinic of the University of Kentucky Medical Center. The patients are 90 per cent white, and

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entirely from the Appalachian Mountain and Central Kentucky regions. A large variety of neoplasms was seen.

One hundred and twenty-two patients were examined in a study at the Radiation Oncology Clinic of the University of Kentucky Medical Center, Lexington, Kentucky. The study was carried out in a "double blind" manner. The samples were taken and transferred to the laboratory, then stored until all the samples of the same patient were collected. The results were obtained only after a conclusion was reached regarding clinical response. The first sample was taken before radiotherapy was started, the second was taken at the midpoint of the radiotherapeutic plan. For example, if the patient was planned for 6,000 rads, the second sample was taken after 3,000 rads. If a patient was planned for 2,000 rads, the second sample was taken at 1,000 rads. In that manner a standardized sampling pattern was followed. The third sample was taken at the end of the treatment and the fourth sample 2 months after the completion of the treatment. CEA levels greater than 2.5 ng/ml. were found in 68 per cent of proved cancer patients in the Radiotherapy Clinic.

Fifty-two patients seen in a Surgical Oncology Clinic and undergoing cancer chemotherapy were studied in an effort to compare CEA response using this modality of treatment. A protocol similar to that used in the radiotherapy study was used for the chemotherapy patients.

Cases grouped by organs. Table 1 shows the distribution of cases by site of origin. These were rather different and reflect the types of cancer cases referred to, and accepted for treatment by, these 2 clinics. Lung, head and neck and gynecologic tumors were common in the Radiotherapy Clinic. Breast and colorectal cancers and sarcomas were more common in the Chemotherapy Clinic and generally were more advanced, often with distant metastases.

Treatment protocols. External beam therapy was ordinarily used for radiation treatment following routine prescription and

TABLE I
CASES GROUPED BY ORGANS

	Radio- therapy Cases	Chemo- therapy Cases
Lung	32	3
Head and neck	15	
Uterus	13	
Colon and rectum	13	11
Lymphomas	11	
Breast	12	24
Skin	5	7
Upper gastrointestine	4	
Urinary tract	3	
Multiple myeloma	3 5	
Prostate and testicle	3	
Ovary	2	
Brain	2	
Sarcomas		7
Pancreas	2	•
	122	52
Tota	ıl—174	•

treatment schedules. Usually cobalt 60 teletherapy was used at dose schedules of about 1,000 rads per week. For chemotherapy, a variety of agents was used. These included 5-Fluorouracil, 5-Azacytidine, Dimethyl Triazeno Imidazole Carboxamide (DTIC), and multiagent combinations. These are shown in Table II. In general, these patients had more advanced and disseminated tumors and this was the usual reason for the chemotherapy.

Table II
CHEMOTHERAPY AGENTS USED

	Cases
5-Fluorouracil alone	20
5-Fluorouracil and combination of multiple- agents	16
5-Azacytidine	5
Hormones	I
DTIC* alone	3
DTIC* and combinations	I
Immunotherapy	3
Other •	3
	52

<sup>\*</sup> DTIC= Dimethyl Triazeno Imidazole Carboxamide.

#### TABLE III

# CODING SYSTEM: PATTERNS OF RESPONSE TO TREATMENT

#### Laboratory CEA Response

- Normal range, detectable, but less than 2.5 ng/ml.
- 2. Sustained elevation, greater than 2.5 ng/ml.\*
- 3. Progressive rise, to levels greater than 2.5 ng/ml.
- 4. Progressive decline, initial levels greater than 2.5 ng/ml.

### Clinical Response

- 1. No clinical evidence of disease
- 2. Widespread tumor or unresponsive tumor\*
- 3. Tumor progression, patient deterioration
- 4. Tumor response or clinical improvement
- X. Uncertain outcome

Coding system: Patterns of response to treatment. One of the major objectives of this study was to devise a system of clarifying response patterns. To describe our data and to correlate clinical and serum CEA response, we used a coding system shown in Table III. The coding system used values I through 4 and a similar code was used for both clinical response and CEA response.

Table IV depicts some of the combinations which could be observed. For example, I-X is an initial normal level, with an uncertain outcome; 4-4 is an elevated initial level with a response to treatment. The first digit represents the laboratory CEA value, the second digit represents the clinical response.

#### RESULTS

Response after radiotherapy. Figure I shows typical curves of CEA levels. Levels could rise, remain the same, or fall. The Figure traces typical response patterns which have been observed. Curve 3 is typical for a nonresponder with progressively rising CEA values. Curve 4 represents a responder with a progressively falling CEA value. The line drawn at the 2.5 ng/ml. level indicates the arbitrary upper limit of normal.<sup>7</sup>

Patterns of response following radiotherapy or chemotherapy. Table IV shows the correlation of CEA and clinical response of tumor to therapy. This is represented by the following pair of digits describing clinical (2nd digit) and laboratory CEA (1st digit) response: 4—4 code (fall with tumor responses); 3—3 code (progressive rise with tumor progression); and I—I code (normal level—no evidence of disease).

In this regard, both radiotherapy and chemotherapy were similar and correlated with clinical response. We observe a paucity of 4—4 responses with chemotherapy compared to radiotherapy, this being 21 per cent with radiation and 6 per cent with chemotherapy. The obvious reason for this is that the radiation treatment patients had more localized tumors, and the chemotherapy patients had, in general, more advanced and metastatic disease which responded less well to the agents administered.

It should be noted that 44 patients in

TABLE IV

CEA CURVES (CODED) AND CLINICAL TUMOR RESPONSE (CODED) AND CORRELATION WITH RADIOTHERAPY OR CHEMOTHERAPY

Pattern	Radiation* Number	Per Cent	Pattern	Chemotherapy† Number	Per Cent
(1-1	16	13)*	[		
3-3	32	26	3-3	31	60
4-4	25	21	4⊤4	3	. 6
•			ļ	_	
	57		į	34	

<sup>\* 16</sup> cases had borderline values >2.5 ng/ml.; 44 cases had no detectable CEA.

† 18 cases had no detectable CEA.

<sup>\*</sup> Based upon experience of an earlier study,19 category 2 was not found to be of any value.

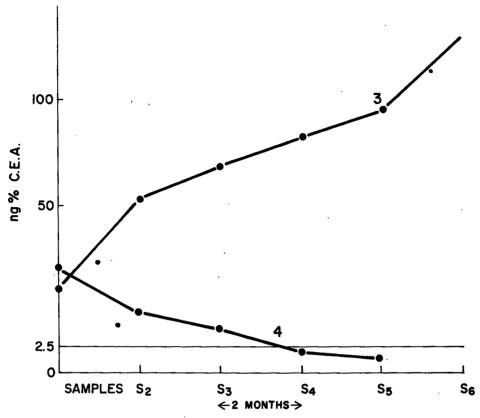


Fig. 1. Response of plasma CEA with treatment. Serial samples are drawn according to the sampling pattern described in the text. Pattern 3 is a progressively rising level of plasma CEA in nonresponders. Pattern 4 is one that falls following treatment in responders.

this series studied in the Radiation Medicine Clinic had non-detectable CEA levels (36 per cent). At the same time, 24 patients in the Oncology Clinic were also negative (35 per cent) in the patient sample studied concurrently. Of the 78 patients with detectable CEA plasma levels in the Radiation Therapy Clinic, 73 patients showed CEA response curves correlating with clinical response to radiotherapy (Table IV); 16 cases had borderline detectable levels  $(\geq 2.5 \text{ ng/ml.})$  and were in the I—I group. In addition, 3 patients (4 per cent) had tumors which were progressing with falling CEA levels; I patient (I per cent) had clinical tumor response with rising CEA levels; and I patient (I per cent) had an uncertain outcome (X-category). Fifty-seven of the cases with positive CEA levels showed response curves which correlated with clinical response (73 per cent). However, this represents only part of the entire patient population studied from the Radiation Medicine Clinic.

In the Chemotherapy group of patients, a progressive rise in CEA levels was observed in 31 out of 52 patients (60 per cent). However, clinical response to drugs was accompanied by a drop in plasma CEA levels and was seen in 6 per cent of the patients studied. These data indicate that correlation between clinical response and CEA response is often seen in cancer patients and the values do trace disease activity and response to treatment.

### DISCUSSION

In this study we presumed that tumor specific and tumor associated antigens were part of the neoplastic process.<sup>7,9</sup> Therefore, the antigen may be a means of monitoring the disease activity.<sup>17</sup> CEA is

an antigen whose association with a number of neoplastic processes has been described, and it has also been shown to reflect, in a general way, the clinical stage of the disease. Thus, the objective in the planning and carrying out of this work was to clarify and extend the interpretation and application of this immunologic test to the monitoring and management of the patient undergoing therapy for malignant disease. The results of this clinical investigation would support such a conclusion, but only in a statistical manner.

In this study the clinical data received a code number and the laboratory data curve received a similar code. The code for the laboratory data was expressed for 4 types of curves: 1, 2, 3, and 4. For the laboratory CEA data, 1 represents a negative result in all samples, 2 represents an elevated plasma level that does not fall or rise, 3 represents a curve which rises on successive samples, and 4 represents a curve that tends to fall (Fig. 1). The same digits were used for the clinical response data: 1, 2, 3, 4, X.

For the clinical evaluation, I represents a patient that appears to be free of disease, e.g., a postoperative Stage I breast carcinoma with total extirpation, or a minimal, microscopic finding with otherwise complete removal of the tumor prior to radiation treatment. Code 2 represents a widespread metastatic tumor, without change by treatment, or an unresponsive tumor by clinical, roentgenologic or other means. Code 3 represents tumor progression, and 4 is for a patient whose tumor is responding, or has improved clinically. A fifth term, X is reserved for the patients in whom the outcome is uncertain, or for the dubious cases whose activity is difficult to determine.

The definitions for the 5 clinical responses after coding are easily stored and they give a comprehensive matching for the laboratory data. This matching procedure was essential for objective evaluation of the cases and their response to treatment.

In general, the response to a tumor in

man may be traced by a number of immunologic features such as humoral factors (e.g., specific cytotoxic antibodies or lymphocytes). There are contradictory reports on screening, diagnosis, and prognosis of cancer patients, and the same contradiction may be expected with respect to management of the patients under treatment. Although a general consensus about the usefulness of the CEA test has not emerged and could not be reached without large statistics based upon many patients, it already appears that CEA seems to be most usefully applied to the patient who is known to have cancer and has a detectable CEA plasma level. Thus, CEA would appear to be most useful in patients who already have a positive first test or who became positive at some other time during the course of the disease, as determined by serial monitoring.

In the studies reported here, we have found that: I. The antigen CEA was found in cancer patients; however, the test was nonspecific and many cancers produced CEA antigen, e.g., breast, lung, gastrointestinal. 2. Following therapy varying levels were observed which correlated with clinical response of disease to treatment in most of the patients treated with chemotherapy or radiotherapy.

We conclude that in a selected cancer patient population, CEA titers >2.5 ng/ml. are often seen and that correlation exists between the several response patterns and clinical response in patients undergoing either radiotherapy or chemotherapy. However, in order to improve the accuracy of the test, an improved assay procedure with greater specificity for colonic carcinoma is required.

#### SUMMARY

We have measured serial carcinoembryonic antigen (CEA) titers in 122 radiotherapy and 52 chemotherapy patients, randomly selected from the patient population of a Radiotherapeutic and a Cancer Chemotherapy Clinic, and correlated with the clinical and follow-up evaluation. Seventy-eight patients or 64 per cent of

the radiotherapeutic patients had detectable CEA levels which represents the majority of these proven cancer patients.

In this group, 57 patients (73 per cent) showed correlation between the curves of CEA response and clinical evaluation of disease activity in the radiotherapy group. Thirty-one of 52, or 60 per cent of patients of the chemotherapy group showed correlation between CEA and clinical response. These data indicate that CEA serum levels parallel, in general, clinical tumor response.

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# TANDEM HYSTEROGRAPHY DURING INTRA-UTERINE RADIUM APPLICATION\*

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LTHOUGH most cervico-vaginal ra-A dium applications are uncomplicated, every now and then one encounters the uncertainty of tandem position. The problem has arisen often enough for our radium service to remedy the situation by a simple modification of one of the afterloading intra-uterine tandems. A few small holes are drilled in the closed end of the holder to allow outflow of contrast medium injected into the open end with aid of a plastic Luer-Lok female adaptor. This "Argyle" disposable adaptor fits any afterloading tandem and comes individually packed and sterilized. This modified tandem (with its adaptor) is kept sterilized for immediate use whenever uterine perforation is suspected.

Figure I (schematic) shows the technique of tandem hysterography. To identify the uterine cavity, only a few ccs of contrast medium are needed which, when slowly injected, should not ordinarily create enough pressure for tubal backflow. Although the theoretical, yet unproved, retrograde dissemination of disease precludes routine tandem hysterography, its use is well justified where knowledge of tandem position is critical. Figure 2, a hysterogram, shows filling of a deviated tandem with contrast medium outlining a space in the right parametrium which is definitely not uterine cavity. The tandem was subsequently removed in favor of transvaginal irradiation since the cervical canal could never be identified. Figure 3 shows large afterloading Manchester ovoids<sup>2</sup> and tandem in place with intra-uterine filling via the latter. With perforation ruled out, the ovoids were loaded in the operating room and the tandem at the bedside.

#### SUMMARY

Low pressure tandem-hysterography offers a simple and immediate method of determining the exact position of the tandem during intra-uterine radium applications, particularly when perforation is suspected.

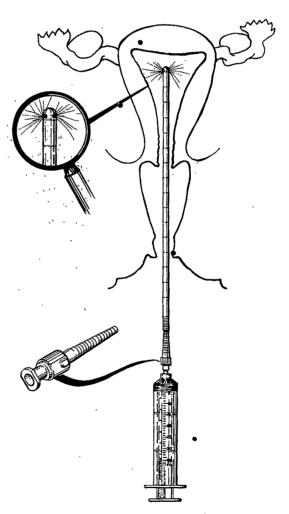


Fig. 1. Schematic drawing of tandem-hysterography showing small holes in one end of the tandem and an "Argyle" Luer-Lok female adaptor on the other.

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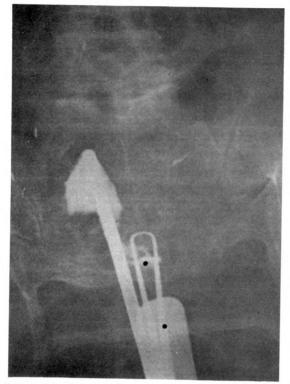


Fig. 2. Tandem hysterogram showing extravasation into right parametrium: perforation.

Any afterloading tandem is easily modified for this purpose and, together with a universal adaptor, may be kept sterilized for immediate use.

Department of Radiation Therapy Charlotte Memorial Hospital Charlotte, North Carolina 28201

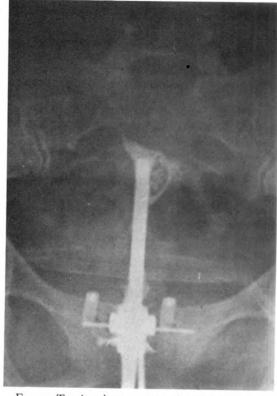


Fig. 3. Tandem hysterogram showing filling of uterine cavity: no perforation.

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# HEPATOMA ASSOCIATED WITH ANABOLIC STEROID THERAPY\*

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SINCE 1971, 10 cases of hepatocellular carcinoma have been reported in patients receiving long term androgenic or anabolic steroid therapy.<sup>2,6–8,12,13,19</sup>

In our patient with Fanconi's anemia, who was treated with anabolic steroids for 50 months and had multiple blood transfusions, the possibility of hepatoma was recognized, and both static and dynamic scintigraphy of the liver was carried out. We are reporting this case in order to call attention to this association and to illustrate the sequential scintigraphic appearance of an avascular hepatoma superimposed upon hepatocellular disease.

### REPORT OF A CASE

T.C.S. (CH211104) was born in August, 1963, prematurely of a gravida 5, para 2, abortions 3 with a birth weight of 4 pounds and 12 ounces. At 4 to 5 years of age, he was anemic and in October, 1968, was diagnosed as having acquired hypoplastic anemia and was given prednisone and methandrostenolone (Dianabol) for 2 months. He experienced a good but transient response, and after 2 months was again profoundly anemic. In May, 1969, he was evaluated in Columbia, Missouri. He was pancytopenic. The bone marrow was normocellular, with scant megakaryocytes and the M:E ratio was 1.8:1. The fetal hemoglobin was 11 mg. per cent, the thrombin, sucrose lysis, and urine hemosiderin tests were negative, and urinary metabolites of tryptophane were normal. The serum iron was 185  $\mu$ g/100 ml. The plasma erythropoietin level was increased approximately 30 times normal. The intravenous pyelogram was normal. The karyotype was normal without chromosomal fragmentation. He was placed on oxymetholone for 13 months and developed a reticulocytosis within 4 months; however, his hemoglobin remained low. The red blood cell morphology remained abnormal with macrocytes and marked poikilocytosis. Red blood cell survival time was significantly shortened. He was given a "hematinic vitamin bomb" which contained pyridoxine, thiamin, riboflavin, vitamin Bi2, niacin, pantothenic acid, folate, ascorbate, vitamin C, and crude liver extract for 2 months, following which the hemoglobin returned to normal with normal red blood cell morphology. The white blood cell count was normal, and platelets ranged from 60-100,000. When the oxymetholone was discontinued, he became pancytopenic again. No effect was seen with 2 more trials of the "vitamin bomb." He had the first symptoms of thrombocytopenia in May, 1971, with gum bleeding. Up to that point he had received only 6 blood transfusions.

The patient was first seen at Children's Hospital Medical Center, Cincinnati, Ohio, in September, 1971. Physical examination revealed a short boy, at the twenty-fifth percentile for height, normocephalic, normotensive, with multiple bruises, petechiae, and patchy areas of skin pigmentation, asymmetry of external ears, short fingers and toes, no radial defects, a large penis, and small testes. The hemoglobin was 6.1 gm. per cent, hematocrit 17 per cent and white blood cell count 3,100 with 33 per cent polymorphonuclear neutrophils, 6 per cent eosinophils, 52 per cent lymphocytes, and 9 per cent monocytes. The fetal hemoglobin was 6.5 gm. per cent. The bone marrow was slightly hypocellular with mild megaloblastic changes. The vitamin B12 level was 500 picograms/ml. The folate was 12 nanograms/ml. Immunoelectro-

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This investigation was supported by Training Grant TIGM 5 To1 GM 01247-14 from the NIGMS, NIH, Training Grant 5-To1 CAO 5196-07 from The National Cancer Institute, Grant RR-00123 from the GCRC branch of the NIH and Grant CI-8B, an Andrew A. Fraser Memorial Grant from The American Cancer Society.

phoresis was normal, and acid hemolysis for paroxysmal nocturnal hemoglobinuria was negative. Chromosomal analysis showed breakage well above normal. Cells cultured from blood with phytohemagglutin had 24 per cent abnormal cells, while cells cultured from marrow without phytohemagglutin showed 15 per cent abnormal cells. The majority of bone marrow cells showed a deleted D chromosome, believed to represent a clone of abnormal cells. The cytogenetic findings are to be reported elsewhere. He was treated with prednisone and the anabolic steroids fluxoxymesterone (Halotestin) or oxymetholone (Adroyd). He continued to have serious bleeding problems including retropharyngeal hematoma, esophageal hematoma, and melena, for which he required blood transfusions every 2 to 3 weeks, and multiple platelet transfusions. In November, 1973 he became profoundly neutropenic, with white blood cell counts below 1,000. In December, 1973, he developed cough, fever, right upper quadrant pain, and hepatomegaly. The chest roentgenogram showed a right middle lobe infiltrate. He was jaundiced with elevated liver enzymes. Bacterial cultures of blood, stool, urine, and sputum were negative, as were urine cultures for cytomegalovirus, and stool exam for Enta-

moeba histolytica. Tuberculin skin test, histoplasma complement fixation test, hepatitis associated antigen test by radioimmunoassay, and the alpha-fetoprotein examinations were negative. A Tc99m sulfur colloid liver scintigram was obtained (Fig. 1). The dynamic study showed that the discrete cold area on the colloid scintigram was avascular (Fig. 2). Oxymetholone was discontinued because of its role in causing hepatic dysfunction. He was treated with methicillin and gentamicin but remained febrile and tachypneic, with a large, tender liver. After 2 weeks clindamycin was added, and clinically he gradually improved, but the defect on the scan persisted (Fig. 3, A-D). The clindamycin was continued for 3 months, and the liver size decreased to normal. A trial of nandrolone decanoate (Deca-Durabolin) of 50 milligrams intramuscularly each week was attempted. He continued to require blood transfusions every 2 to 3 weeks and had continued elevation of bilirubin and liver enzymes. Repeat scintiscans continued to demonstrate the lesion (Fig. 3, E-H). In May, 1974 he developed a headache and progressive loss of consciousness and died as a result of an intracerebral hemorrhage.

At necropsy a hepatic tumor measuring  $4 \times 3.5$  cm. was found. It was pale, and histologic sec-

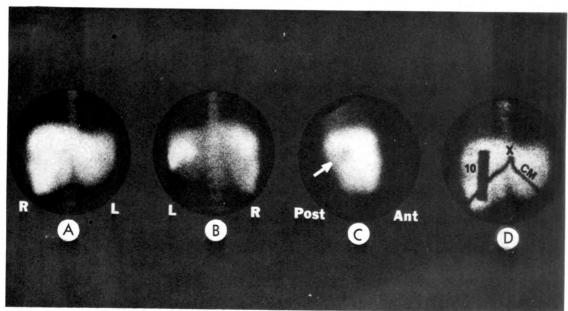


Fig. 1. Tc<sup>99m</sup> sulfur colloid liver scan on December 19, 1973. Anterior (A), posterior (B), right lateral (C), and anterior (D) views with 10 cm. marker (10) demonstrate an enlarged liver with heterogeneous uptake of radioactivity, increased density of splenic uptake, spinal bone marrow uptake of radiocolloid, and a focal defect in the posterolateral part of the right lobe (arrow in C). Xiphoid (X) and costal margin (CM) are marked in D.

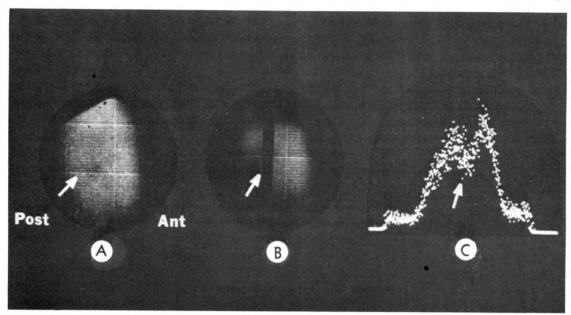


Fig. 2. (A and B) Selected frames (retrieved from magnetic tape and displayed digitally) from arterial phase of dynamic flow study December 21, 1973, done in right lateral position with 5 mc of  $Tc^{99m}$  sulfur colloid shows absent vascular perfusion of the focal defect (arrow in A). A count profile (C) was taken through a slice of liver (arrow in B) which included the cold area. The decrease in activity seen visually on the analog scintiphoto is confirmed graphically (arrow in C).

tion showed a well differentiated hepatoma, devoid of any hemosiderin as was present in the other portions of the liver. There was no evidence of cirrhosis.

### DISCUSSION

The original liver and spleen scintigraphy was obtained not only to locate a possible abscess, but also because of the known association between long term anabolic steroid therapy and the development of hepatocellular carcinoma. The fact that our patient was febrile, had acute hepatitis, and may have had subclinical hepatitis previously, complicated our differential diagnosis.

It is well known that fibrosis associated with cirrhosis, cysts, neoplasms, and abscesses can all become manifest as a cold area on sulfur colloid scintiphotos. 11 Recently, a cold intrahepatic focal lesion in acute viral hepatitis has been reported. 9 Dynamic hepatic scintigraphy has been advocated to differentiate vascular from avascular processes. Hepatomas have been almost uniformly reported as vascu-

lar.<sup>1,3-5,15-18</sup> This is so because arteries are usually not invaded, and, along with the tumor vessels present in these neoplasms, provide the basis for the tumor's visibility during the dynamic vascular study.<sup>15</sup> Dynamic scintigraphy should not be confused with blood pool imaging,<sup>10</sup> in which hepatomas often appear similar to normal liver tissue.<sup>14</sup>

The initial static scintigram and dynamic study showed hepatocellular disease which was manifested by a diffusely enlarged heterogeneous liver, and by increased spleen and bone marrow uptake. The cold area present was dynamically avascular and this suggested either an abscess or a fibrotic pseudotumor (Fig. 2). Hepatoma was thought less likely. A 67 gallium or 75 selenomethionine study was not done.

We perform liver scintigraphy with Tc<sup>99m</sup> sulfur colloid. The time required to obtain 300,000 counts, with the gamma camera positioned anteriorly over the liver to include the right lobe and as much of the left lobe as possible, is noted and used for all other views. We feel that this technique

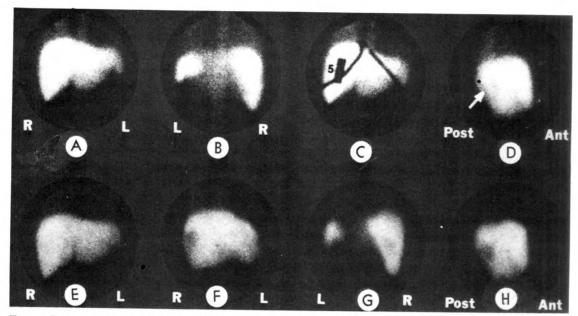


Fig. 3. January 18, 1974. Anterior (A), posterior (B), anterior scintiscan with 5 cm. marker (C), and right lateral (D) views show decrease in liver and spleen size, but continued bone marrow activity. The focal defect is present, but less well defined (arrow in D).

April 19, 1974. Anterior (E), right anterior oblique (F), right posterior oblique (G), and right lateral (H) views demonstrate the lesion which has become very well defined. On a repeat dynamic study (not shown) the lesion continued to be avascular.

enables us to make a more accurate visual assessment of differences in relative liver and spleen uptakes of radiocolloid. At Children's Hospital Medical Center, a high resolution collimator is used with the Ohio Nuclear Series 100 Radioisotope Camera.

Dynamic scintiphotography is done utilizing the Series 100 camera coupled to an Ohio Nuclear Series 150 Data System. One second frames are obtained for 60 seconds. Visual impressions are verified with area of interest and count profile determinations (Fig. 2).

Liver scintigrams in the other reported cases of anabolic steroid induced hepatomas included 2 with single filling defects, 2 with multiple defects, and 1 with a diffuse infiltrative process. Two patients did not have a liver scan done and 3 patients had normal liver scans. None of these patients had a dynamic hepatic study. Five of these 10 patients had Fanconi's anemia, 4 had idiopathic aplastic anemia and 1 was under

therapy for impotence.

#### CONCLUSION

Nuclear radiologists should be aware of the association between anabolic steroid therapy and hepatocellular carcinoma. Liver scintigraphy provides the prime mechanism for discovering focal lesions in patients whose other liver function studies are often abnormal secondary to hepatitis, cirrhosis, or drug induced hepatocellular toxicity. As this case illustrates, avascularity on the dynamic study cannot rule out hepatoma from the list of differential diagnostic possibilities.

#### SUMMARY

A patient with Fanconi's anemia who developed a hepatoma after 50 months of therapy with anabolic steroids is reported. The lesion presented as a cold focal defect on a Tc<sup>99m</sup> sulfur colloid scintigram, but was avascular on dynamic scintigraphy. Both the unusual avascularity of the

hepatoma, and its association with anabolic steroid therapy are discussed.

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Cytogenetics was done by Dr. S. Soukup.

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# CEREBRAL INFARCTION DIAGNOSIS BY COMPUTERIZED TOMOGRAPHY\*

# ANALYSIS AND EVALUATION OF FINDINGS

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THE advent of computerized cranial tomography (CT) represents a great advance in the diagnosis of a very wide variety of intracranial lesions, including cerebral infarction.1 Certainly, computerized tomography at present gives no direct information concerning the status of the cerebral vasculature, either extracranial or intracranial (except the presence of a large blood pool, as in arteriovenous malformations and large aneurysms following high dose contrast enhancement), but it yields a clear demonstration of the anatomical relationships of most infarctions. CT demonstrates whether the area of maximal involvement is deep or superficial, large or small, hemorrhagic (except for the presence of petechial hemorrhages) or nonhemorrhagic, and whether or not the lesion is associated with significant brain swelling. sufficient to produce mass effects, such as displacement of the midline structures. ventricular distortion, or compression of subarachnoid spaces. Although another essentially noninvasive technique, radionuclide scanning, is available and has been used for a number of years, the clarity with which the CT image depicts the relationship of the abnormality to the normal structures and the capability of differentiating many infarcts with hemorrhage, and other intracerebral hemorrhages from ischemic infarction, at the appropriate time from onset, is far superior to radionuclide scans as used currently. Additionally, CT yields evidence of brain damage from old infarction, information rarely obtainable from static technetium pertechnetate radionuclide (RN) imaging.

Much still needs to be known, but the authors feel that enough information has now been gathered to warrant an attempt to clarify and analyze all of the known facts regarding the value of computerized tomography with the EMI scanner in the diagnosis and management of patients with cerebral infarction. Although part of this study was prospective, most of the analyses were performed in a retrospective manner.

#### MATERIAL

A total of 1,800 CT examinations was reviewed to select the cases discussed here. This point was chosen because the higher resolution system (160×160 matrix) then replaced the 80×80 matrix. Only I case, hemorrhage into an infarction, was examined with the 160×160 matrix and included in the tabulation. During this time, there were 270 discharge diagnoses of infarction from the Massachusetts General Hospital. Of this material, 209 CT scans on 185 patients led to an initial diagnosis of cerebral infarction, but 88 scans on 84 patients were eliminated for various reasons, such as a questionable later discharge diagnosis of infarction, or a technically suboptimal study, leaving a total of 101 patients available for analysis. Four patients had separate areas of old infarction and recent infarction, and were therefore listed as 8 separate cases (101+4=105). This resulted in a total of 105 cases and 121 scans (Table 1).

All patients had the diagnosis suggested by a typical clinical course and follow-up. Angiography and radionuclide scanning

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† Supported in part by NINDS, Neuroradiology Special Fellowship 5F 11 NS 02586-02.

TABLE I GENERAL DATA

Age	Females	Males
Less than 20 years	2	I
20-39 years	· I	4
40-49 years	7	4
50-59 years	7	16
60-69 years	9	16
70-79 years	7	14
80-89 years	5	8
·	38	63
	(40 cases)	

99 per cent Caucasian; 53 per cent hypertensive; increased intracranial pressure in 4 patients (2 subarachnoid hemorrhage, 1 hemorrhagic infarction, 1 cerebellar infarction).

were obtained in many of the cases. In order to determine the absolute accuracy of CT scanning in the diagnosis of cerebral infarction, histologic proof would be required in every case. Since this was not practical, the best alternative would have been to carry out the study prospectively, with exhaustive correlation between the neurologic history and examination and the angiographic, pneumoencephalographic, radionuclide scan, and available autopsy findings. Since this was done in only the limited number (3) of cases coming to autopsy, we shall content ourselves for the present with an approximate answer to the question of diagnostic accuracy.

#### FINDINGS ON CT SCANNING

The cases were empirically divided into 4 categories: (1) Acute infarcts included pale or petechial hemorrhagic infarcts within 28 days from onset. Since petechial hemorrhage into the gray matter may not be detected by the CT scan or suspected on clinical evaluation, some of these cases may have been included as pale infarcts. Lacunar infarcts and hemorrhage into an infarct are excluded. (2) Old infarcts were taken to be infarcts over 28 days from onset, excluding hemorrhage into an infarct, and lacunar infarcts. This category may include some old petechial hemorrhagic

infarcts. (3) Lacunar infarcts are exclusive of the other 3 categories (Table II). (4) Hemorrhagic infarcts include only hemorrhage into a previously occurring infarct, the only type of hemorrhagic infarct found to be distinguishable.

#### ACUTE INFARCTS

Acute infarcts were ordinarily manifested as an area of diminished absorption, usually reaching the cerebral cortex. This was the most common configuration, although many did not reach the surface. Sometimes the abnormal area assumed a roughly triangular shape with the base towards the periphery. The area of diminished absorption measured most frequently between 5 and 15 EMI units3 throughout the 28 day time period. At no time did any case measure over 20 units at the upper level. The over-all appearance of the area of diminished absorption was not homogeneous in the acute stage. As the time from onset increased, multiple areas of homogeneity were seen. (Occasionally, the adjacent ventricle was compressed early by swelling, and subsequently enlarged after 3-4 weeks from onset.) All 52 scans in this group were classified as having heterogeneous absorption (Fig. 1; and 2). In the acute early stage of cerebral infarction the diminished absorption is probably produced by tissue swelling. The margins of the lesion are illdefined. In many instances, the ill-defined edge of a recent infarct is visibly more sharply demarcated after 8 days (Table III). Paxton and Ambrose<sup>3</sup> found that some of the patients examined more than

TABLE II
TYPE OF INFARCT

	Cases	Scans
Acute infarct	44	52
Old infarct	49	55
Lacunar infarct	9	11
Hemorrhagic infarct	49 ct 9	3
	P	
,	105	. 121

nore clearly defined low density area. After 14–18 days, the multiple small homogeneous areas seen within a large heterogeneous low absorption infarction area are probably due to liquefaction necrosis. As the process of tissue breakdown, phagocytosis, and removal continues, cystic spaces, filled with fluid and seen as low absorption homogeneous areas, replace the parenchyma. Eventually, these cavities contain fluid which has the same absorp-

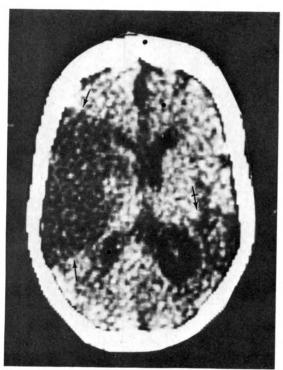


Fig. 1. Acute and old infarcts. (160×160 matrix for illustrative purposes. Not included in tabulation.) The very large acute infarct, 48 hours since onset, is seen as a large heterogeneous area (--) of low absorption (5-15 EMI units). The area encompasses the superior and inferior divisions of the left middle cerebral artery. There is mass effect upon the left lateral ventricle with midline shift to the right. The patient was a hypertensive 72 year old female in atrial fibrillation, who had sudden onset of right hemiparesis and global aphasia. The old infarct (++) is shown as low absorption abnormality in the distribution of the inferior division of the right middle cerebral artery, accompanied by dilatation of the atrium, adjacent slit cavity and enlargement of overlying subarachnoid space.

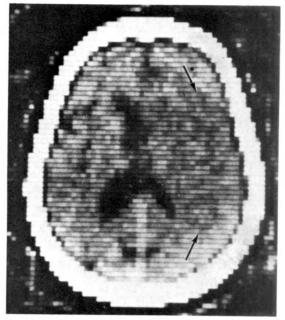


Fig. 2. Acute infarction. Four days prior to the scan, this 89 year old female with a cardiac murmur was found stuporous with a left hemiparesis. A poorly defined large area of low absorption abnormality is seen in the distribution of both divisions of the right middle cerebral artery (→). Slight mass effect is shown by the compression of the right lateral ventricle and minimal midline shift.

tion characteristics as cerebrospinal fluid. The damage to and increased permeability of the capillary walls (associated with early necrosis of the cerebral tissue) due to ischemia, which in a large infarct may be

Table III

CORRELATION OF ACUTE AND OLD INFARCTS: CT

VISIBILITY FROM TIME OF ONSET\*

Days	Negative No. Per Cent	Equivocal No. Per Cent	Positive No. Per Cent		
0—2	I (20)	2 (40)	2 (40)		
3-7	2 (18)	3 (27)	6 (55)		
0-7	3 (19)	5 (31)	8 (50)		
8-14	2 (12)	2 (12)	13 (76)		
15-21	I (8)	4 (33)	7 (59)		
22-28	0	2 (17)	5 (83)		
> 28	1 (2)	7 (13)	47 (85)		

<sup>\*</sup>One hundred and seven CT scans are included: 37 cases of acute infarct had a single scan; 7 cases had serial scans; 47 old infarcts had a single scan; and 2 cases had serial scans.

Since there were few cases in the 0-2 and 3-7 days from onset group, a 0-7 day category was also used.

most marked in the central gray matter, may possibly be shown by injecting high doses (e.g., 100 ml. Hypaque 60 M or more) of intravenous iodine contrast material which normally remains in the intravascular pool (Fig. 3). In view of the altered capillary permeability in cerebral infarction, the occasional instance of dramatic increase in density after high dose intravenous contrast medium injection is believed to be due mostly to diffusion of the iodine compound into the tissues. The diffusion into a damaged area may have some relationship to the phenomenon of hemorrhage into infarcted brain tissue during anticoagulation treatment when the embolus has fragmented and passed distally. Increased density in a previously low absorption area has been seen once in 6 cases examined after contrast medium injection. This occurred in an infarct in the central gray matter, in a scan performed 13 days after onset of symptoms and following intravenous injection of 100 ml. of Hypaque 60 M. In the same patient, examined 7 days previously, no increase in density of the low absorption area was observed after the same injection. The patient was again re-examined 2 months later, at which time a smaller area of residual low absorption abnormality did not increase in density after contrast medium injection (Fig. 3).

Because the upper level of the range of the absorption coefficients was under 20 EMI units (without contrast material) in all cases, any significant increase over this figure in a case of suspected acute infarction should raise the question of either hemorrhagic infarction or another diagnosis, such as intracerebral hemorrhage or tumor (see below).

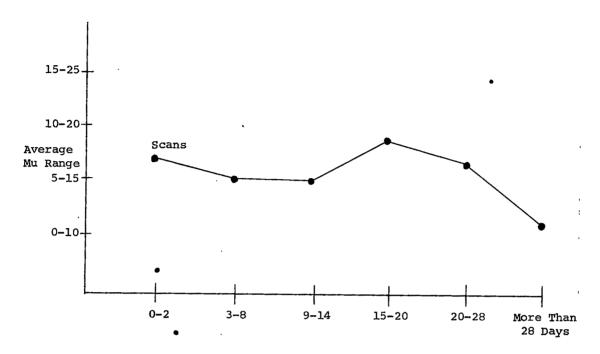
A mass effect was observed in 9 of 44 total CT cases and 8 of 31 angiograms obtained in the acute infarct group (Table IV; and Fig. 1).

#### OLD INFARCTS

Old infarcts (over 28 days) presented as areas of diminished absorption which

tended to be more homogeneous than in the first 28 days. In the later stages the tissue swelling has disappeared, unless there has been another insult in the interim, and the peripheral zone of necrosis has gone through a process of phagocytosis. The process of phagocytosis continues until all the necrotic debris has been removed leaving a cavity, or cavities, filled with clear fluid. These spaces are seen as homogeneous, very low absorption areas on the scan, and the margins are sharply demarcated compared with recent infarcts (Table III; and Fig. 4). Ultimately, the cavity is traversed by fine strands of connective tissue and blood vessels. These are not within the resolution capability of the CT scan. The time from onset to the examination has been plotted against the EMI units in Figure 4, which graphically demonstrates the lowered average absorption values in the old infarcts. The older infarcts, particularly after several months, are usually more sharply circumscribed, exhibiting a large cystic region or multiple small cystic areas, with 0 to 10 range absorption values, if the area of cavitation occupies the full slice thickness (Fig. 5; and 6). In some cases, without an obvious area of cavitation in which there may be small poorly demonstrated multiple cystic changes, the old infarction is reflected by local or generalized enlargement of the lateral ventricle and adjacent sulci. A midline shift toward the affected side may be occasionally observed (8 out of 55 cases) (Fig. 5). A cystic space within the brain may appear to communicate with the adjacent ventricle, yet autopsy may reveal a thin velum separating ventricle and cavity (Table v; and Fig. 8). In general, it is not possible to differentiate such thin and irregularly disposed vela owing to limited CT resolution, partial volume averaging effects, and the similar absorption ranges of cerebrospinal fluid and the fluid in the cavity.

We know from examination of pathological specimens, however, that even large infarcted areas do not usually communicate with the ventricular system. From pneu-



Time from Onset (Days)
Fig. 4. Average density range in EMI units from time of onset: acute and old infarcts.\*

\* Negative scans excluded.

tral gray matter and the brain stem, and are no more than approximately 10 mm. in diameter. Consequently, they are difficult to visualize on CT scanning. No instances of "lacunar" infarcts have been seen on scan by us in the early stages of development, and therefore no statements can be made as to their appearance. The difference in the ranges of absorption values from the adjacent normal tissue is expected to be slight in the early stages, and the small volume of involvement would usually be averaged within the slice with adjacent normal tissue, resulting in difficulty in detection. An old lacunar infarct, after approximately 2 months from clinical onset, may appear as a relatively homogeneous cavitated area of lower absorption, measuring no more than approximately 10 mm. in diameter. Small lacunae may be situated almost entirely within a single point on the matrix, and it is difficult or impossible to distinguish them from random effects. It should be possible to demonstrate old lacunar infarcts better by using the 8 mm. slice capability of the scanner and possibly also by changing the angle of cut to follow a plane parallel to the canthomeatal line, instead of at an angle of 20-25° caudad, as is customary in our practice. It is the feeling of the authors that these technical modifications may result in a clearer definition of such small lesions. In the future, it is expected that further improvements in technique and instrumentation will show such smaller lesions more clearly. The recent introduction of the 160×160 matrix system by EMI Ltd. has not, in our opinion, resulted in increased visibility of these lesions. However, experience with the new

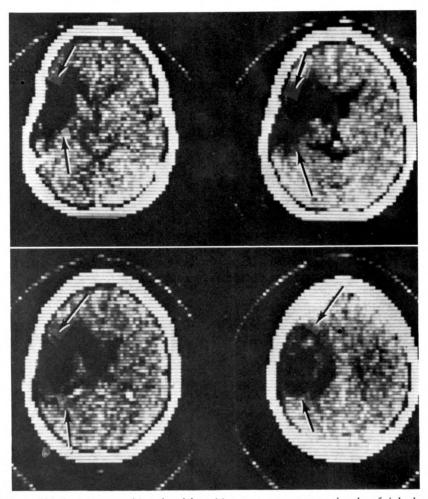


Fig. 5. Old infarct. This is a 57 year old male with sudden onset 7 years previously of right hemiparesis and aphasia. He showed moderate recovery of the hemiparesis and was having 4-5 seizures per month. A homogeneous low absorption (1-10 EMI units) cavitary abnormality is present in the left middle cerebral artery distribution ( $\rightarrow$ ). The left lateral ventricle is larger than the right, and the midline is shifted slightly to the side of the lesion.

matrix is short, and a final conclusion would be premature.

### HEMORRHAGIC INFARCTION

Hemorrhagic infarction, as discussed here includes only considerable hemorrhage into an infarct. No case of petechial hemorrhage was identified on CT scan. One case had macrophages containing hemosiderin surrounding pinhead to 5 mm. hemorrhages, autopsied 5 days after demonstrating bland infarction on CT scan. This suggested a false negative scan. Another case was found to have petechial hemorrhagic infarction in the cortical gray matter at

autopsy 24 days later and, therefore, was too late for a meaningful correlation with the scan. The petechial hemorrhages were not shown on CT scan, and were either absent or not large enough to be seen at the time of the scan. It is not to be expected that true small petechial cortical hemorrhages could be distinguished. Such hemorrhages occupying only a small fraction of a CT section thickness, would not be distinguished from the relatively high absorption of normal gray matter (18–30±4). Confluent petechial hemorrhages, however, might be visible.

Our cases of hemorrhage into the area of

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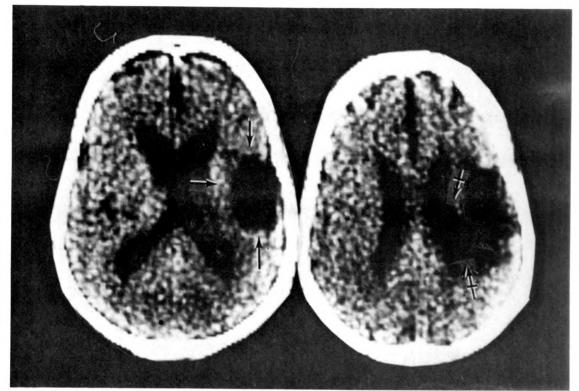


Fig. 6. Old infarcts. (160×160 matrix for illustrative purpose only. Not included in tabulation.) Four months prior to the scan, this 75 year old patient sustained a myocardial infarction with hypotension and hypoxia resulting in a persistent left hemiplegia. A homogeneous low absorption (0-13 EMI units)cavitated infarct is present in the right middle cerebral artery distribution (→). The right lateral ventricle is enlarged, and the area of cavitation is in close contact with the ventricle on the higher slice (++).

infarction all had a clinical course suggest- blood to re-enter the original artery. We as-

ing that an original embolus had frag- sume that the necrotic tissue comprising mented and passed distally while the pa- the infarct from the original embolus, foltient was being anticoagulated, allowing lowing anticoagulation, was then exposed

TABLE V COMMUNICATION OF INFARCT WITH VENTRICLE: ACUTE AND OLD INFARCTS AS SEEN ON CT SCAN; NUMBER OF SCANS\*

•	Ven	Apparent atricular aunication	Ver	uivocal ntricular nunication	Apparent Ventricular Communication		
	No.	Per Cent	No.	Per Cent	No.	Per Cent	
Acute infarct	46	(100)		0		0	
Old infarct	34	(62)	12	(20)	Q	(18)	
Old-heterogeneous	17	(85)	3	(15)	,	0	
Old-homogeneous	17	(50)	9	(25)	9	• (25)	

<sup>\*</sup> Six negative CT studies are omitted. Old homogeneous infarcts are large, homogeneous low cerebrospinal fluid range absorption areas of cavitation. Heterogeneous old infarcts have the appearance of multiple smaller separated areas of cavitation, probably with fronds of cerebral tissue projecting between the cavities.

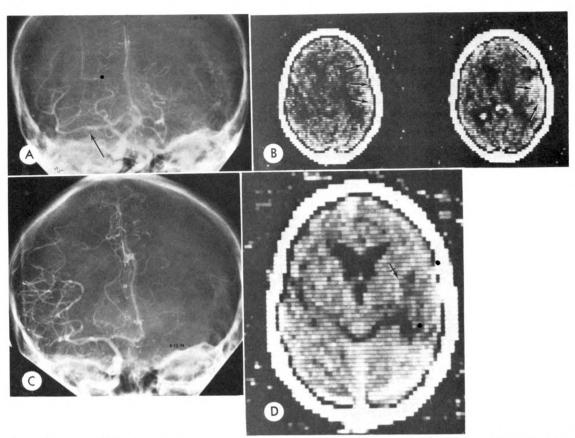


Fig. 7. Hemorrhagic infarction. This 75 year old male, with an old myocardial infarction and atrial fibrillation, had sudden onset of left hemiparesis, hemisensory deficit, hemianopia, and facial weakness. (A) Right brachial angiogram on the day of onset showed a right middle cerebral artery stem embolus with escape of a few superior division branches ( $\rightarrow$ ). Retrograde filling of the inferior division occurred. After being given heparin, he became worse and the CSF became xanthochromic. (B) CT scan, 8 days from onset, showed a heterogeneous high absorption (20–33 EMI units) hemorrhagic abnormality in the right posterior frontoparietal cortical region ( $\rightarrow$ ). Medially, a heterogeneous low absorption (8–17 EMI units) infarction abnormality is seen in the right middle cerebral artery distribution, associated with mass effect and midline shift. (C) Repeat angiogram on the fourteenth day showed spasm, mass effect, and no evidence of embolus. (D) Repeat CT scan after several months showed low absorption old infarct residua ( $\leftrightarrow$ ).

to the full force of the arterial blood pressure, with resulting hemorrhage through damaged capillaries. One of the 3 cases 8 days prior to the CT scan had an angiogram which showed an embolus in the stem of the middle cerebral artery. The patient then deteriorated, while on anticoagulants, and was thought to have bled. The CT scan showed hemorrhage into the peripheral area of infarction, and a second angiogram 5 days later showed spasm from subarachnoid hemorrhage and no longer any embolic obstruction. A CT scan several months later showed low absorption old

infarct residua (Fig. 7). Another of the 3 cases demonstrated the largest area of hemorrhage. This was a patient with atrial fibrillation, I week post myocardial infarction, who deteriorated within 24–28 hours after being anticoagulated for an embolic infarct. (The patient died and autopsy permission was not obtained.) The third patient, previously anticoagulated for atrial fibrillation and rheumatic heart disease, sustained an embolic infarct, and deteriorated within 36 hours. Angiography at 2 days from onset showed middle cerebral artery stem occlusion, and CT scan at 16

days after onset showed hemorrhage into an infarct.

Hemorrhage into an infarction may be diagnosed because its configuration differs from that seen in frank intracerebral hemorrhage. In the latter, the usually deeply seated area of homogeneous increased absorption values representing the recent hematoma is sharply circumscribed and is not surrounded by more than a quite narrow zone of decreased absorption values (perifocal edema). On the other hand, the majority of instances of hemorrhage into an infarction are located in cortical (or central) gray matter, are generally more heterogeneous centrally and peripherally, are more irregular in contour, and are surrounded by a wide irregular low absorption zone. Thus, it is felt that the two can usually be distinguished with a considerable degree of certainty. The absorption coefficient of the hemorrhagic component of the infarcts included in this report ranged primarily within 20-45 units, which is in the same range as previously established for blood.4

Four cases of multiple infarcts, old and new in each case, were encountered. These were felt to be embolic in origin.

#### MASS EFFECT

The early accompanying tissue swelling is sometimes sufficient to produce a mass effect (Table IV). The "mass" may not be sharply circumscribed and usually produces only mild local ventricular compression and displacement (Fig. 1). An important differential feature between infarcts and neoplasms is that the latter usually produce a greater degree of ventricular deformity and midline displacement than do infarcts of similar size and absorption abnormality. A mass effect is found only in the early phase. However, it must be kept in mind that successive insults could be superimposed, thus lengthening the acute swelling phase. The clinical history then usually suggests the step-like progression of the process. The mass effect and the midline shift correlated well with the angiographic findings in most of the cases where angiography was performed at approximately the same time. However, in I case a slight frontal mass effect was seen on CT at 13 days from onset, but not on angiography at 12 days from onset. The presence of major vessel occlusion may interfere with angiographic visualization of the mass effect. Another case had CT and angiography on the same day. A mass effect was demonstrated by angiography only.

#### PATHOLOGICALLY PROVED CASES

Three of the 105 cases came to autopsy:

CASE I. (Fig. 8.) Clinical Course: An 87 year old male had the first of 2 strokes 6 months before death, presenting with sudden onset of left hemiparesis, left homonymous hemianopia, and left-sided neglect. Three months before death, a CT scan showed the 3 month old right posterior temporo-parieto-occipital infarct with suspected porencephaly of the trigone. Two days after the CT scan, a radionuclide scan showed bilateral subdural hematomas, but was negative for the infarct. The bilateral subdural hematomas were evacuated. The second CT scan was performed 2 months before death and was without change. One month before death, he had a second stroke with sudden onset of jargon, right homonymous hemianopia, right hemisensory deficit, and right hemiparesis, which progressed to a hemiplegia by the next morning. There were bilateral cortical blindness and deafness. Angiography on that day showed a left middle cerebral artery inferior division embolic occlusion with retrograde filling. The third and last CT scan, 11 days after the last stroke, showed a left fronto-temporo-parietal infarction, without mass effect. The previously noted areas were unchanged. He died 5 days

Autopsy Findings: Encephalomalacia of the right parietal, lateral superior temporal, and lateral occipital lobes, dated in terms of 2 to 6 months, was found, which explained the 6 month old infarct. Almost total occlusion by an atheroma was found in the left middle cerebral artery inferior division, and also distal to the anterior temporal branch of the superior division. Prior emboli that had broken up were suspected in these areas. Bilateral parieto-occipital infarctions involved the superior temporal gyri and optic radiations, explaining the clinical

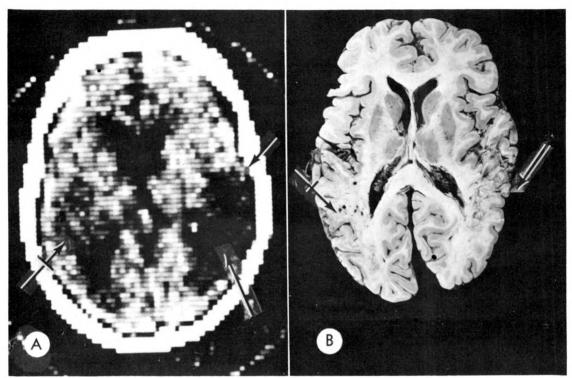


Fig. 8. Acute and old infarcts. (A) CT scan. There is a right posterior temporo-parieto-occipital somewhat homogeneous low absorption area of old infarction, with suspected porencephaly of the trigone ( $\rightarrow$ ). Heterogeneous low absorption abnormality is evident in the left temporo-parietal region from a stroke II days previously ( $\leftrightarrow$ ). (B) Autopsy section. (5 days after CT scan.) Encephalomalacia of the right parietal, temporal, and occipital lobes (approximately 6 months old) is seen ( $\rightarrow$ ). No communication is present between the cavitated infarction and the ventricle. A more recent left parieto-occipital infarction is associated with small pinhead to 5 mm. hemorrhages in the left optic radiation ( $\leftrightarrow$ ). Therewere macrophages containing hemosiderin in this area, suggesting at least 5 days' duration of the hemorrhages.

cortical blindness and deafness. Many small hemorrhages (not seen on CT scan 5 days earlier), varying from a pinhead in size to 5 mm. in diameter, with surrounding hemosiderin laden macrophages, were seen in the involved white and gray matter near the left optic radiations, especially at the junction of the white and gray matter. No communication was seen between the right lateral ventricle and the cystic cavitated infarction. There were small areas of encephalomalacia, all old, in the left parieto-occipital junction and left cerebellar hemisphere, which were-probably embolic in origin, had no known clinical correlation, and were not seen on CT.

CASE II. (Fig. 9.) Clinical Course: A 57 year old female had a craniopharyngioma for the past 28 years, which had been treated with irradiation. Two months prior to death, a ventriculo-atrial shunt revision and, 5 weeks prior

to death, a partial excision of the tumor were done. She developed a left hemiparesis 2 days after subtotal resection and then became hemiplegic and comatose. A CT study 13 days post-operatively showed extensive cerebral infarction in the left frontal, temporal, parietal, and both occipital regions.

Autopsy Findings: (28 days following CT study). Recent infarctions were found in the left middle cerebral artery and the distribution of both posterior cerebral arteries. No occlusive disease was present. The craniopharyngioma (2.2×2.0×2.0 cm. mass) extended from the third ventricle cavity to the medial aspect of the right cerebral peduncle.

CASE III. (Fig. 10.) Clinical Course: A 59 year old male had a sudden onset of subarachnoid hemorrhage, secondary to ruptured aneurysm. Mild right long tract signs, abutia, and bloody cerebrospinal fluid were found. Nine

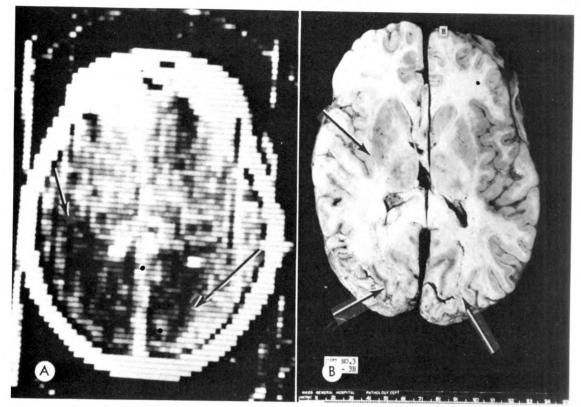


Fig. 9. Acute infarctions. (A) CT scan. Thirteen days after onset, low absorption values representing infarction are present in the left temporal, parietal, and both occipital regions (→). (B) Autopsy section. (28 days after CT scan.) Infarctions are identified in the left middle cerebral artery and both posterior cerebral artery distributions (→).

days later, after he became bilaterally decerebrate, an angiogram showed bilateral anterior and middle cerebral arterial spasm, with bilateral middle cerebral and right supraclinoid internal carotid artery aneurysms. A CT scan, 3 days later, showed bilateral parieto-occipital, posterior temporal, and posterior frontal infarctions, with a bilateral mass effect compressing the ventricles and shifting the midline to the left. He died on that day.

Autopsy Findings: Encephalomalacia was found in both parietal lobes, and both frontal lobes, with edema. Subarachnoid blood from ruptured aneurysms was present. There was bilateral uncal herniation, the left greater than the right.

### DISCUSSION

The number of positive scans was not significantly affected by the length of time after the first 7 days from onset of symptoms to the performance of the CT scan

(Table III). The number of patients scanned in the first 2 days was small, but the data suggest that a scan very early after onset may commonly be negative. A mass effect from tissue swelling was seen 2-4 days from onset in infarction due to occlusion of both divisions of the middle cerebral artery. This is in keeping with known microscopic changes of cell death after 12 hours and tissue swelling 2-4 days from onset of infarction. (More cases are needed in which the examination was performed within the first 48 hours, and subsequently, in order to answer this question adequately.) The appearance of the visualized infarct tended to vary in relation to the length of time from onset of symptoms, resulting in greater visibility in many cases, particularly with large infarcts, up to approximately 2 months from onset, with a constant appearance after that.

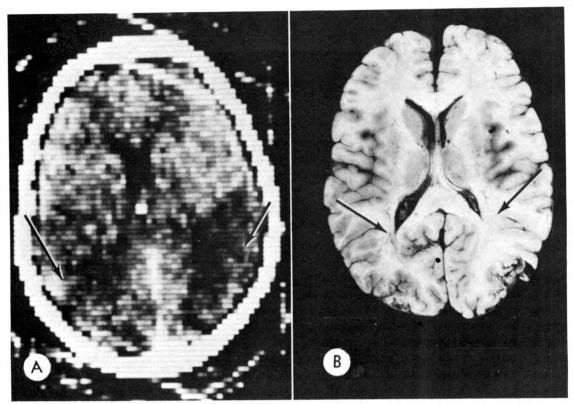


Fig. 10. Acute infarct. (A) CT scan. Three days after becoming bilaterally decerebrate and showing spasm on angiography from ruptured aneurysm, the scan shows bilateral parietal occipital, posterior temporal, and posterior frontal low absorption areas of infarction  $(\rightarrow)$ . (B) Autopsy section. (Same day as CT scan.) Encephalomalacia in both parietal and frontal lobes  $(\rightarrow)$  with edema was found.

Serial scans were performed in 11 patients. Seven of these patients had positive scans that were repeated and were unchanged. Two patients had repeat CT scans which remained negative. The first of the latter 2 patients had a middle cerebral artery embolic occlusion seen at angiography on the day of onset, a negative CT scan and static technetium pertechnetate radionuclide scan on the third day, and a negative CT scan on the ninth day. The second patient had a left hemisensory deficit, a clinically suspected lacuna, a negative static radionuclide scan on the second day, and negative CT scans on the fourth and thirty-fourth days, but no angiographic confirmation.

Two patients had repeat CT scans that converted from positive to essentially negative. The first patient had a clinical diagnosis of left cerebellar hemisphere

infarct, with a positive CT scan on the seventh day, a slight angiographic mass effect at the same time, a negative static radionuclide scan on the eighth day, and a negative repeat CT scan on the twenty-first day. The second patient, suspected clinically of having a right cerebellar infarct, had an angiogram which showed a right posterior inferior cerebellar artery occlusion on the fourth day, and a positive CT scan on the eighth day, which converted to essentially normal on the fifteenth day.

The great majority of infarcts was located both superficially and deep (72 cases), and 18 were deep only. Of the 18 deep infarcts, 9 were felt to be lacunar on clinical grounds.

#### DIFFERENTIAL DIAGNOSIS

The most common differentiation to be

made is between infarction and glioma when the latter presents only diminished absorption. The abnormal area of infarction is usually located within a major vessel distribution, reaching the surface. There is a smaller mass effect with infarction, and the shift is seen early only. Old infarctions may produce a shift to the ipsilateral side and focal ventricular enlargement, rather than compression. More midline shift may be seen with infarcts secondary to spasm from subarachnoid hemorrhage due to aneurysm. In cerebellar infarction, there may be hydrocephalus. The appearance on serial studies is valuable for differentiation. An infarct shows progressive change during the first month after onset, whereas a tumor usually appears unchanged or little changed during this period of time. Homogeneous areas of low absorption appear in the first weeks after onset in infarction, and may progress within 2 months to obvious cavitation. Calcification is often present in low grade gliomas, and is not seen with infarction. Injection of intravenous contrast material may result in increase in absorption values in some or all of a glioma. Rarely is there an obvious increase in values after contrast material injection in infarction and, when present, it would be only in the first few weeks after onset. The clinical course is usually helpful in differentiation. An infarct may have sudden onset without progression of the neurological deficit. A glioma usually has a slower, progressive course of neurologic deterioration.

Angiography is usually the most informative examination in the first few days. An old infarct may have an old occlusion on angiography, and shift of the midline toward the infarct, but the findings may be less obvious. Angiography may be entirely negative, and this is usually in cases where emboli have undergone lysis. The CT findings of a cavitated area, focal ventricular enlargement, and occasional shift of the midline toward the lesion are relatively easier to identify and interpret than the angiographic findings in old infarction.

Correlation with the static RN scan

may be of assistance in differentiating infarct from glioma. The RN scan is helpful in acute infarction due to the changing pattern of the blood-brain barrier with time on serial scans. Two-thirds to three-quarters of all infarcts produce a positive static scan 10-14 days from onset. The static RN scan is usually negative in the first few days after onset, and usually becomes negative again after I month from ictus. The anatomic display on CT scan is usually more informative early (the mass effect from tissue swelling), and particularly late in the course of infarction than is the static technetium pertechnetate demonstration of blood-brain barrier alteration on RN scan. Gliomas usually do not exhibit much change during I month. The infarct on RN scan is often in a major vessel distribution, appearing as a wedge, based on the cortex. A decrease in uptake on the cerebral radionuclide angiogram, when seen, would also suggest infarct rather than glioma.

The second most common problem in differential diagnosis of infarction is the possibility of a solitary metastasis. The simplest way to resolve the problem is to repeat the CT scan after a high dose of intravenous contrast material (300 ml. drip infusion using 150 cc. of 60 per cent concentration of contrast medium) to demonstrate more than I lesion or to increase the absorption values of the solitary lesion.<sup>2</sup> All or some of the lesions may increase in value. The other suggestions for differentiation of glioma from infarct also apply to the solitary metastasis. A later repeat scan may reveal a second lesion. Occasionally, 2 contiguous lesions seen as one large lesion on CT scan are clearly separated on angiography or RN scan and vice versa. The clinical history is also of great importance in differentiation of a solitary metastasis from infarct. An old cavitated infarct on CT scan is not a problem in differentiation from a solitary metastasis, because of the characteristic CT findings of a cavitated infarct, as given

Exclusion of a small petechial hemor-

rhagic infarction on CT scan, before anticoagulation and when acute, may not be possible. Petechial hemorrhages were not identified in our cases. It is probable that the high absorption values of the central and cortical gray matter obscure the small hemorrhagic areas, which are averaged with similar gray matter values. An area of recent hemorrhage into an area of prior infarction (seen after anticoagulation of an acute infarct in our cases) will be seen as a 20-45 EMI unit heterogeneous high absorption hemorrhagic region, surrounded by low absorption infarct abnormality. A glioblastoma with hemorrhage into a necrotic center may appear similar to hemorrhage into an infarction, but the clinical course usually serves to differentiate these two processes. Bleeding into certain metastases, particularly those of malignant melanoma, may occur; however, the multiplicity of lesions provides the clue to the correct diagnosis in most instances. There are features that differentiate a hypertensive intracerebral hemorrhage from hemorrhage into an infarction. The former has a generally narrow, low absorption periphery, a more homogeneous blood (high) absorption range centrally, may be associated with intraventricular hemorrhage, especially if located in the thalamic region, and is shown on angiography as an avascular mass. The static radionuclide scan will usually be negative (except for occasional uptake into the hemorrhage by technetium diphosphonate). Angiographic findings of the hemorrhagic infarct are similar to other acute infarcts, unless the hemorrhage has entered the subarachnoid space and has produced spasm. The radionuclide scan of hemorrhagic infarction will be similar to the scan of other infarcts (except that technetium diphosphonate may also produce increased uptake in the center of the lesion).

Inflammatory lesions are also included in the CT differential diagnosis of infarction. The radionuclide scan may be more sensitive earlier in an abscess or in herpes simplex encephalitis. A changing pattern may be seen over several weeks. The CT scan may be negative in these cases early after onset, and the radionuclide scan may be positive. No mass effect may be present early. After several days, on CT scan, the periphery of a heterogeneous appearing low absorption area of abscess may increase in absorption following intravenous injection of contrast material. An early positive static radionuclide scan and a negative CT scan do not ordinarily suggest infarct. Early after onset, angiography may be less sensitive than the radionuclide scan and the CT scan. The clinical history is very helpful.

Demyelinating disease and focal atrophic processes may produce findings similar to old infarction on the CT scan. The major vessel distribution may suggest old infarction, and clinical correlation may be confirmatory. Angiography and radionuclide scanning may be negative.

Since lacunae have been seen only when old, the small cavitary findings may be similar to those in any focal degenerative process. Clinical correlation is necessary. The residua of an intracerebral hemorrhage in the thalamic region may be in the process of forming a slit from an area of cavitation, appearing similar to a lacuna. Clinical correlation and serial scans will usually separate the processes. Angiography and radionuclide scanning are of little value.

#### DIAGNOSTIC ACCURACY

Determination of absolute accuracy, by histologic proof, is not possible due to a limited number of cases (3) coming to autopsy. Additionally, assessment of our diagnostic accuracy is further limited because some of the negative scans were in patients accepted on clinical features alone as having had an infarction. CT, angiography, and radionuclide scan findings were related to time from onset. The different types of examination on a given patient were most often not done on the same day, and therefore no comparison can be made.

Evaluation of the positive CT scans was made in relation to the time from onset in all patients with clinical evidence of infarction (Table III). The conclusions are as

# OLD INFARCTS - C.T. AND R.N. VISIBILITY

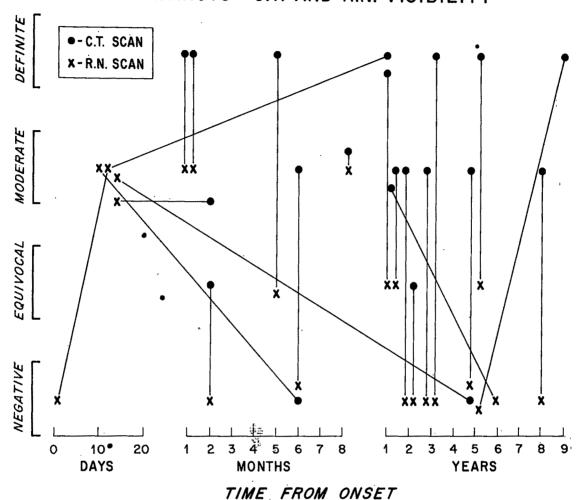


FIG. 11. Old infarcts. CT and RN visibility. Each line represents a patient. The CT scan (a dot) is more often positive than the RN scan (an X) in old infarction.

follows: (1) there are probably more positive CT scans at 3-7 days than at 0-2 days from onset, in spite of the small number of cases; (2) 8-14 days would be the best time to see an acute infarct, if it is to be seen at all; and (3) a high percentage of old infarcts (after 1-2 months) produces positive scans.

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# PATIENTS WITH BOTH CT AND STATIC RADIONUCLIDE SCANS

The same case was usually not examined by both modalities in the same time period. A re-examination by either method may have also been done in another time interval (Table vi). The tabulation shows: (1) CT scans in the first week were positive almost twice as often as the radionuclide scans (often due to the anatomic display of a mass effect on CT); (2) positive CT and RN scans were almost equally frequent in the second week. It is interesting to note that some cases had positive RN scans and negative CT and vice versa; and (3) the CT scan was positive more than 4 times as often as the radionuclide scan, 28 days or more from onset (Fig. 11).

## PATIENTS WITH BOTH CT AND ANGIOGRAPHY

Again, the same case was usually not examined by both modalities in the same time period. Additionally, a case may have

Table VI

CT CASES WITH RADIONUCLIDE (STATIC) SCANS: ACUTE AND OLD INFARCTS\*

Days from Onset	• Negative		CT Scans Equivocal		Positive		Negative		RN Scans Equivocal		Positive	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
0-2		0	I	(50)	ı	(50)	I	(50)		0	1	(50)
3-7		0	2	(50)	2	(50)	4	(45)	3	(33)	2	(22)
0-7		0	3	(50)	3	(50)	, 5	(46)	3	(27)	3	(27)
8-14	ĭ	= (15)	1	(15)	5	(70)	2	(16)	2	(16)	8	(68)
15-21	1	(17)	2	(33)	3	(50)	' 2	(100)		ò		o
22-28		ò	1	(100)	·	o		ò		0		0
> 28		0	2	(10)	17	(90)	,10	(55)	5	(28)	3	(17)

<sup>\*</sup>Twenty cases of acute infarcts, all having 1 CT and 1 RN scan per patient, except 1 patient with 2 radionuclide scans, made a total of 20 CT scans and 21 RN scans. There were 19 cases of old infarcts with 3 patients having 2 radionuclide scans each for a total of 19 CT and 22 RN scans. The positive RN scans more than 28 days from onset, were 37 days, 1 month, and 8 months, respectively, from onset. Since the number of cases is small, the 0-2 and 3-7 day groups are tabulated separately, and together as a 0-7 day group.

been re-examined in another time interval. The tabulation shows: (1) within 2 days from onset of clinical evidence of infarction, angiography was obtained much more often than CT scan and was usually abnormal; (2) both CT scan and angiography had a high incidence of positive findings 3-7 days from clinical onset of infarction; (3) 8-14 days from clinical onset of infarction, the CT scan was done more often and was positive more often than the angiogram in this limited number of patients; and (4) beyond 28 days from clinical onset of infarction, the CT scan was positive more often than the angiogram.

#### SUMMARY

CT has been found to be of value in cerebrovascular disease. In acute infarcts, the CT (before anticoagulation) excludes intracerebral hemorrhage. The CT may not exclude small petechial hemorrhagic infarctions (with negative cerebrospinal fluid). Angiography, otherwise, is more informative, disclosing ulcerative, irregular plaques, stenosis, emboli, etc.

In old infarcts, the CT may differentiate an old infarct from a tumor in a patient with focal seizures. Angiography and radionuclide scans are less informative.

CT is a valuable investigative agent for

clinico-anatomic correlation in cerebrovascular disease.

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Seventy-sixth Annual Meeting: Marriott Hotel, Atlanta, Ga., Sept. 30-Oct. 3, 1975.

#### AMERICAN RADIUM SOCIETY

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Representative on the Board of Chancellors of the American College of Radiology: Luther W. Brady, Philadelphia, Pa.

Representative to the Council of the American College of Radiology: Juan A. del Regato, Tampa, Fla.

The Fifty-eighth Annual Meeting: Vancouver, British Columbia, Canada, May 9-14, 1976.

# 🗚 EDITORIAL 🛎

# AMERICAN RADIUM SOCIETY ANNUAL MEETING

THE Fifty-seventh Annual Meeting of the American Radium Society was held at the Americana Hotel in Isla Verde, Puerto Rico from May 4 through May 9, 1975. There were more than 60 presentations with 280 registrants. The officers for the meeting were as follows: President: Victor A. Marcial, M.D.; President-Elect: Felix N. Rutledge, M.D., First Vice-President: Alfred S. Ketcham, M.D.; Second Vice-President: Morris J. Wizenberg, M.D.; Secretary: Richard H. Jesse, M.D.; and Treasurer: Luther W. Brady, M.D.

The Scientific Program Committee was chaired by Victor A. Marcial, M.D. and the Arrangements Committee was chaired by Dr. Luis A. Vallecillo.

The tenor of the program was timely, scientifically significant, and of direct clinical usefulness.

The Scientific Program opened on May 5, 1975 with the Presidential Address, given by Dr. Victor A. Marcial, entitled "The Role of the Clinician in Community Cancer Control Activities." Dr. Marcial discussed in detail the program in Puerto Rico and the impact that it has had on cancer care in this region, as well as in the development of centralized cancer facilities.

The panel discussion was directed toward the role of radiation therapy in the management of primary breast carcinoma. The moderator was Dr. Gilbert A. Fletcher and presentations were directed toward various aspects of breast carcinoma. Dr. Stephen Gallagher noted that the final objective in breast cancer is increased survival rates. He pointed out that the manipulations of therapeutic modalities probably would not produce an increase of the desired magnitude. About 50 per cent of the patient discovered breast cancers are disseminated

prior to the initial treatment program and neither surgery nor radiation therapy or combinations of both would be expected to increase survival, if this state of affairs existed. He went on to discuss the pathologic aspects of the disease, pointing out that there did exist a stage of the disease that is detectable, in a high percentage of cases, by mammography. At this point, the probability of extramammary spread would be less than 5 per cent. Evidences are now apparent that treatment of this lesion by modified radical mastectomy results in 5 year survival rates of 97 per cent. Also, there was good reason to believe that partial mastectomy plus radiation therapy in this type of patient would result in equally good survival rates. Dr. Gallagher, in his experience, pointed out that a number of patients treated at the M. D. Anderson Hospital by preoperative irradiation had no tumor in the histologic examination after mastectomy. It was obvious that the keystone of treatment for minimal breast cancer is clearly either the surgical removal of or irradiation of at least the totality of the mammary tissue on the affected side.

Dr. Umberto Veronesi continued the discussion with regard to conservative surgery in breast cancer, reporting the experience obtained at the Cancer Institute of Milan regarding surgical treatment consisting of resection of the breast with axillary dissection, modified radical mastectomy, radical mastectomy, enlarged mastectomy, and super radical mastectomy. The more conservative treatment program was applied in T<sub>1</sub>, N<sub>0</sub>, M<sub>0</sub> cases and consisted of a wide resection of the breast with simultaneous axillary dissection, plus radiation therapy of the residual mammary tissue. Thirty patients had been treated by this procedure

from 1968 to 1972. In 1973, a clinical trial was initiated to compare the treatment of patients with T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> lesions with N positive. In a group of premenopausal patients treated by radical mastectomy, there were 140 evaluable patients with 25 relapses. In the other group treated with Cytoxan, Methotrexate, and 5-Fluorouracil, there were 126 evaluable patients with 5 relapses at 21 months. In the postmenopausal group, there were 10 out of 26 relapses in a control group and I out of 24 relapses in the patients receiving the Cytoxan, Methotrexate, and 5-Fluorouracil therapy at 21 months with a probability of 0.004. The data presented by Dr. Veronesi supported the contention that multied drug therapy following surgery in breast cancer does improve the relapse-free survival rate.

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Dr. Bernard Fisher reported the results in the national clinical trials of primary and adjuvant breast treatment, discussing in detail the patients treated by radical mastectomy, total mastectomy with radiation therapy, and total mastectomy with a negative axilla. In each group, there was no difference in survival at 36 months. In those individuals who had a positive axilla, there was no difference in survival at 36 months between those treated by radical mastectomy versus those treated by total mastectomy and radiation therapy. He went further to report that the patients entered into the L-Phenylalanine mustard study were stratified to those who were premenopausal and those who were postmenopausal. In the group who had L-Phenylalanine mustard following the mastectomy and who were postmenopausal there was no difference in the two groups. In those who were premenopausal, there were 11 out of 37 recurrences in the patients who had only surgery with one recurrence out of 30 patients who had the L-Phenylalanine mustard. It was pointed out that the recurrences in the postmenopausal patients were on the chest wall and a significant number of the premenopausal patients also had recurrence on the chest wall in both groups. Dr. Fisher went on to discuss the ThioTepa study which had been initiated in 1957 and was now evaluated for survival at 10 years. He pointed out that there was a 20 per cent difference in survival between those patients who received Thio-Tepa at the time of the breast surgery versus those who did not. The numbers in this group, however, are very small and the difference between the two groups revolves on 5 patients. Dr. Fisher concluded that prolonged chemotherapy is a sound premise, the argument among the various surgical techniques to be employed is not as important as it might seem to be, that the basic aim was for better survival with the best cosmesis free of disease and the possibilities of less surgery. His presentation was controversial in character.

Dr. Bernard Pierquin discussed radiotherapy in the management of primary breast carcinoma, reporting the results of several teams of radiotherapists in France since 1960. The results presented involved lesions that were T-1 and T-2 in character treated by radiotherapy alone, and indicated that the results at 5 years are comparable with those of surgery. Dr. Pierquin suggested that these methods are justified for moral and esthetic reasons, leading to a better quality of life for the patient and, for technical reasons, in that surgery would be possible later in the event of local failure.

Dr. Gilbert H. Fletcher presented the dose and volume of cancer in adenocarcinoma of the breast, discussing the volume of cancer ranging from subclinical disease in the supraclavicular area, internal mammary chain, and apex of the axilla to various size lymph nodes in the axilla and, sometimes, even enormous masses in the breast. Dr. Fletcher pointed out that subclinical disease in the breast and the lymph nodes draining the breast is possible when adequate dosages of radiation are delivered. A review of the data to support the efficacy of radiation therapy in controlling local and regional recurrences was presented in detail, establishing the efficacy of radiation therapy, not only following tumorectomy or segmental resection of the breast, but as an adjunct to surgery in the prevention of local and regional recurrence, when the dosages of radiation are adequate.

Following a wide-range discussion of the panel presentations, subsequent papers were delivered regarding various aspects of breast cancer. Dr. Paul E. Wallner discussed subtotal mastectomy and radiation therapy in the definitive management of localized breast malignancy, supporting the contention made by Dr. Fletcher of the efficacy of the treatment technique with a minimal local and regional recurrence rate.

Dr. Norah duV. Tapley discussed the utilization of the electron beam for carcinoma of the breast after mastectomy. It was pointed out that the chest wall and the lymph nodes draining the breast should be irradiated when more than 20 per cent of the axillary lymph nodes are positive, when the tumor mass in the breast is greater than 5 cm. in size, when there is fixation to the pectoral fascia, where there is skin edema, fixation or erythema, where there are multiple foci of invasive tumor within the breast, or where vascular perineural or lymphatic invasion in the breast is noted histologically. In the interval from 1963 to 1970, 444 patients were treated with the electron beam after radical mastectomy for breast cancer. The analysis of the results indicates the value of elective radiation of occult deposits of disease, since local recurrences were avoided.

Dr. Harold G. Sutton discussed the results of ultrafractionation radiation therapy in breast carcinoma as carried out at the University of Chicago. Since 1952, an ultrafractionation, postmastectomy radiation therapy technique has been employed with tissue dosages of 5,000 to 6,000 rads being given over a period of 12 weeks to the regional lymph nodes in the chest wall. The technique was carried out using kilovoltage, with 260 patients being analyzed. There was a 3 per cent local recurrence rate, 12.5 per cent local and metastatic disease rate with a 5 year survival of 57 per cent and a 20 year survival of 27 per

cent. The median survival in the group was 6.9 years.

Dr. Nael Martini discussed the management of malignant pericardial effusion. Twenty-eight patients with malignant pericardial effusion were treated primarily by intrapericardial instillation of radioactive chromic phosphate in the interval from 1968 to 1974. The disease was secondary to primary carcinoma within the breast or lung in about 75 per cent of the patients. Five millicuries were utilized within the pericardial sac. Twenty of the 28 patients had no further problems with the effusion after the initial tap and the P-32 instillation. Eight required one additional pericardial centesis 1 to 5 months later.

Dr. Omar M. Salazar discussed the value of high-dose radiation therapy in the treatment of glioblastoma multiforme. The program was introduced 3 years prior to presentation at the University of Rochester Cancer Center with patients being treated to the whole brain with a dose of 5,000 rads minimum to 6,000 rads maximum. The tumor volume was boosted to 6,500 rads minimum to 8,000 rads maximum. Twelve patients were treated in this regimen, all 12 being alive at the time of the report from 6 to 24 months with 5 being alive at 1 year. The author points out that these results are superior to those achieved in 70 cases treated with standard dosages ranging from 5,000 to 6,000 rads prior to the onset of the present study.

Dr. Arthur J. Gerdes reported on the experiences of the fast neutron beam radio-therapy program for glioblastoma multiforme at the University of Washington. Twenty-one patients were treated in the program receiving 1,800 neufron rads in 6 to 8 weeks. Sixty-two per cent of the patients were alive at 6 months and 23 per cent alive at 12 months. Of those patients who came to autopsy, the examination revealed no evidences of residual tumor.

Dr. Fransiska Lee discussed a randomized study of two dose schedules in radiotherapy of glioblastoma multiforme carried

out at the Edward Mallinckrodt Institute of Radiology. Sixty-three patients were randomized into two groups with 26 receiving low dose schedule and 37 receiving a high dose schedule. The I year survival in the low dose group was 48 per cent with a 2 year survival of 3I per cent and a 3 year survival of II per cent. In the high dose group, the I year survival was 47 per cent, the 2 year survival was 30 per cent, and the 3 year survival was 7 per cent with no significant difference between the two groups. No complications were noted with the dosages employed.

The Second Scientific Session began on May 6, 1975 with a symposium on the prevention of metastases, chaired by Dr. Vincent DeVita of the National Cancer Institute. Dr. DeVita pointed out that as many as half of the patients with the diagnosis of cancer have disseminated disease at the time of diagnosis, even though they may not be detectable with current diagnostic techniques. The advent of effective forms of systemic therapy with acceptable toxicities has made it possible to utilize these modalities of therapy in patients with early disease. Much of this evidence has been developed from experimental animal tumor systems. Data from cooperative studies indicate that surgery or radiation therapy as a local form of treatment combined with either chemotherapy or immunotherapy as systemic treatment gives rise to a significant therapeutic gain.

Dr. Frank Schabel discussed the concepts for treatment of micrometastases developed in murine systems, with Dr. George Canellos discussing the clinical results with combined modalities from surgery and chemotherapy. Dr. Canellos pointed out the review of the Thio-Tepa data utilized as adjuvants in the surgical management of carcinoma of the breast. The 10 year results of this treatment indicate that the survival was increased in those patients who had Thio-Tepa where the lesion was less than 3 cm. in diameter. The numbers are small and the data should

be interpreted with great care, since the difference between the two groups relates to only 5 patients. Dr. Canellos also reviewed briefly the L-Phenylalanine mustard data in conjunction with surgery in the management of breast carcinoma. The failures were mostly on the chest wall in this group. The combination of Cytoxan, Methotrexate, and 5-Fluorouracil has given significant improvement in the recurrencefree survival in patients with carcinoma of the breast, indicating that it is better than the L-Phenylalanine mustard data. Dr. Canellos also discussed the applicability of chemotherapy with surgery in the management of patients with osteogenic sarcoma, indicating that Adriamycin following surgery resulted in a decrease in the incidence of metastasis and an increase in the period of survival, data similar to that reported utilizing high-dose Methotrexate therapy with citrovorum rescue following surgery. It was also pointed out that the risk from this treatment was great.

Dr. Fred Eilber discussed the applications of surgery and immunotherapy in the prevention of metastasis, pointing out the importance of host resistance and, specifically, of the immune system in the hosttumor relationship. The original experience with immunologic therapy was gained in the treatment of patients with disseminated malignant melanoma. Thirty-five patients were treated by direct intratumor injection of BCG. Of the 754 nodules injected, 684, or 91 per cent, regressed and 6 out of 36 patients had regression of uninjected nodules. Encouraged by these results in disseminated disease, a pilot study was begun with 144 patients with malignant melanoma in the interval from 1972 to 1975. Operative procedures were carried out to remove all detectable tumor and, subsequently, BCG as well as allogeneic tissue cultured melanoma cells were used in treating the patients. The analyses show improved recurrence-free and survival rates for each stage of the disease treated with immunotherapy. Sixteen patients had

Stage I disease and 84 patients had Stage II disease with a survival of 96 per cent in Stage II, 67 per cent in Stage II, and 27 per cent in Stage III from 24 to 36 months following surgery.

Dr. Thomas Pomeroy discussed the applications of radiotherapy and chemotherapy with specific reference to the use in Ewing's sarcoma. The combinations of chemotherapy and radiation therapy including irradiation of the cerebral spinal fluid axis gave improved survival in patients with Ewing's sarcoma. Lesions of the trunk so treated resulted in 70 per cent 2 year survivals.

Dr. DeVita summarized the presentations by pointing out that combination modality therapy offers a significant potential in terms of improved results of treatment. Much needs to be done in terms of further cooperative clinical trial studies to explore the various avenues of this innovative approach to the problem.

Dr. Ernest Ngo discussed the effect of therapeutic irradiation on the immune responses. He pointed out that out of the four quantitative immunoglobulins, IgG seemed to be affected most by radiation. During radiation therapy, an increase in IgG was noted followed by a return to normal levels following therapy in most cases. Those patients for whom levels remained higher than the normal population or who dropped to very low levels, indicated that the radiation therapy did temprorarily depress the immune system. Various other studies were carried out in order to test the validity of the premise and these included a lymphocyte culture for in vitro lymphocyte transformation tests using phytohemagglutinin (PHA), convanavalin A (Con-A), pokeweed mitogen (PWM), and streptolysin O. Skin tests were done utilizing mumps antigen, PPD, and dermatophytin. Patients anergic to these antigens were sensitized with DNCB.

Dr. Mehat Khafagy discussed the effect of different modalities of cancer treatment on the immunity to an antigenic transplantable fibrosarcoma (Meth A). Tumor specific transplantation immunity to Meth A fibrosarcoma was not uniquely augmented by different methods of treatment to the primary tumor (therapeutic irradiation, preoperative irradiation, or prior surgery) in comparison to excision alone or simple tumor ligation. Dr. Khafagy pointed out that the presence of residual tumor exerts a profound, depressive effect on specific tumor immunity to Meth A.

Dr. Tapan Hazra reported on the transformation delay of lymphocytes from patients undergoing radiotherapeutic treatments. Thirty-seven patients with lung cancer were tested utilizing the transformation response of lymphocytes to mitogenic stimulation. Transformation indices as well as lymphocyte populations were observed. The data demonstrated the delay effects of radiation treatment on lymphocyte transformation response.

Dr. Philip Lepanto reviewed the application of Gallium-67 scans in children with solid tumors. Over-all, Gallium-67 was unable to differentiate between malignancy and reactivity in soft tissues. The sensitivity from the test was low in the various solid tumors tested. These included Hodgkin's disease, soft tissue sarcomas, neuroblastomas, Wilms' tumors.

Dr. Umberto Veronesi reviewed the staging laparotomy in Hodgkin's and non-Hodgkin's lymphomas performed at the Istituto Nazionale Tumori in Milan, Italy from September 1970 to December 1974. Five hundred and fifty staging laparotomies were performed in all types of malignant lymphomas. The incidence of splenic involvement was about the same in the two groups of lymphomas. Non-Hodgkin's lymphomas showed a higher incidence of occult involvement in the liver, bone marrow, and mesenteric lymph nodes compared to Hodgkin's disease. Dr. Veronesi discussed the application of peritoneoscopy with needle marrow biopsy before laparotomy. This technique may be applicable in the staging of patients with lymphomas, thus eliminating the necessity for exploratory laparotomy.

Dr. H. Jung Ree reviewed the histologic characteristics correlated with survival patterns in non-Hodgkin's lymphoma.

Dr. Jerome M. Vaeth reviewed the unique situation of mediastinal Hodgkin's disease with no evidences of disease in other locations. Fifty-five patients with Hodgkin's disease were seen from 1965 to 1974 with 12 of these having mediastinal involvement, but 5 cases had mediastinal involvement with no disease in other locations (Stage IA). The control rate in this disease process is high, with 4 out of 5 patients treated free-of-disease at 5 years.

Dr. Komanduri Charyulu reviewed the treatment program for mycosis fungoides at the University of Miami, reviewing in detail the technique for treatment using the electron beam. Fourteen patients were treated under this particular protocol.

Dr. Mostafa Batata discussed cancer of the undescended or maldescended testis. One thousand, five hundred and sixty-one patients were examined: 436 demonstrated cryptorchidism and 45 tumors were noted in this group of patients in the interval from 1934 to 1973. There were 17 seminomas, 15 embryonal carcinomas, 10 teratocarcinomas, 2 choriocarcinomas, and 1 reticulum cell sarcoma. Five year survival was 62 per cent in the unrepaired cases and 13 per cent in the repaired cases. The survival was related to histologic type and stage, and whether the testis was within the scrotum or not. Five year survival was 75 per cent in seminomas and 15 per cent in the other tumors. Dr. Batata reaffirmed the role of radiation therapy in the management of these patients.

The third Scientific Session on May 7, 1975, under • Dr. Felix Rutledge's chairmanship, dealt with a review of the management of carcinoma of the endometrium. Dr. Rutledge reviewed in detail the treatment programs, at the M. D. Anderson Hospital, outlining those factors that relate to prognosis (stage, cell differentiation, depth of myometrial involvement, age at diagnosis, and menstrual state) as well as the role of preoperative radiation therapy

in the management of the disease. Four hundred and four patients with Stage I adenocarcinoma of the endometrium had surgical exploration. Fifty of these patients showed disease more extensive than involvement of the uterus. Four were surgically staged at Stage II, 21 at Stage III, and 25 at Stage IV. Dr. Rutledge also pointed out that the absence of residual disease within the uterus at the time of hysterectomy reflected a good prognosis. Also, Stage II disease requires more aggressive treatment in order to achieve control. The program recommended for Stage II adenocarcinoma of the endometrium involved whole pelvis irradiation with a radium placement and subsequent hysterectomy. bilateral salpingo-oophorectomy and wide vaginal cuff resection. The utilization of progestational agents in adenocarcinoma of the endometrium is established as a significant and important part in the armamentarium of treatment.

Dr. Creighton Edwards discussed estrogen receptors and the estrone hypothesis in relation to endometrial and breast cancer. The hypothesis indicates that the exclusive production of estrone by anovulatory subjects indicates a high risk for the development of endometrial or breast cancer. This hypothesis suggests that unopposed exposure of target tissues to estrone may be a causal factor in the development of cancer.

Dr. Julian P. Smith discussed the utilization of chemotherapy in the disseminated or recurrent endometrial carcinoma. The utilization of progestational agents is a major and important adjunct in the treatment of this particular disease.

Dr. Paul Morrow discussed the role of postoperative irradiation in the management of endometrial carcinoma, indicating the efficacy of surgical management as the primary means of treatment in endometrial cancer with the utilization of postoperative radiation therapy in those patients when indicated. The advantages for the utilization of postoperative radiation therapy are related to accuracy in staging and

they allow for optimal individualization of radiation therapy, diminish the treatment time, diminish the treatment cost, as well as diminishing the treatment complications.

Dr. Jose Sala discussed the practical aspects of radiation in the management of endometrial cancer at the community level

Dr. R. C. Landgren discussed endometrial cancer in patients with medical contraindications to surgery or who have unresectable lesions. One hundred and twenty-six patients were reviewed who were medically inoperable and 28 patients with lesions that were technically unresectable. These were treated definitively by radiation therapy techniques alone. Survival data were excellent in terms of local control and survival.

Dr. Irving J. Weigensberg presented the data on 91 patients treated preoperatively by radiation therapy techniques in endometrial carcinoma. The patients were randomly allocated to receive either external beam irradiation or a single intracavitary Heyman packing plus an intrauterine tandem and vaginal ovoids. Total abdominal hysterectomy was done following the radiation therapy technique 4 to 8 weeks later. The 5 year survival in the 54 patients receiving intracavitary irradiation was 86 per cent. The 39 patients in the external beam group showed a cumulative diseasefree survival of 62 per cent at 5 years. The results indicate, on the various parameters judged, that intracavitary irradiation is superior of the 2 regimens tested.

Dr. Vitune Vogtama discussed the treatment of 115 cases of Stage I and Stage II sarcomas of the corpus uteri. These were patients who had Stage I and Stage II disease including 24 leiomyosarcomas, 29 endometrial stromal sarcomas, 33 mixed mesodermal sarcomas, and 29 carcinosarcomas. The prognostic factors were histology, the size of the uterus, the depth of myometrial invasion, the stage of the disease, and the treatment technique employed. The evidence suggested that im-

proved survivals and diminution in recurrence rates were best in the treatment program involving combined radiation therapy and surgery.

The Resident Award Paper was given by Dr. Ralph R. Weichselbaum and dealt with the inherent cellular radiosensitivity of human tumors of varying clinical curability. Dr. Weichselbaum suggested that the wide-range of curability seen among various human tumors cannot be explained on the basis of inherent cellular factors responsible for the survival of tumor cells after x-irradiation.

The Janeway Lecture for the Fiftyseventh Annual Meeting of the American Radium Society was given by Dr. George C. Lewis, Jr., Professor of Obstetrics and Gynecology at the Thomas Jefferson University in Philadelphia. The title of his presentation was "Ovarian Cancer: Multifacet Disease; Multifarious Therapy and Therapists." Dr. Lewis discussed the various prognostic factors in ovarian cancer that were important in determining the end results of treatment. The difficulties in designing appropriate clinical trial studies, because of these multiple factors, and the potentials for new avenues of treatment in ovarian cancer. Dr. Lewis also discussed the program supported by the National Cancer Institute involving national cooperative clinical trials in the treatment of ovarian cancer as directed by the Division of Cancer Research, Resources, and Centers and the Division of Cancer Treatment. His plea was for better cooperation and integration of the efforts of these two divisions of the National Cancer Institute.

The Fourth Scientific Session dealt with the place of interstitial therapy in today's radiotherapy. The philosophy behind this therapeutic procedure, its advantages and disadvantages, as well as the importance of factors such as volume and time in relation to the dose delivered, the indications of the procedure, its results and possibility to improve its results were discussed in detail.

Dr. H. T. Barkley presented data on

volume and time factors in interstitial gamma ray therapy, discussing the various ramifications of the Patterson and Parker system. He discussed the importance of the isoeffect curve and how it has been widely used as well as the relationship between the isoeffect curve and the NSD concept.

Dr. Basil S. Hilaris discussed low-energy gamma radionuclides for permanent interstitial implantation, representing a presentation of considerable experience using Iodine-125 seeds. This technique has been used at Memorial Hospital for almost 10 years and has been compared with radon-222 and iridium-192. The analysis of the results using the Iodine-125 seeds indicates that it is a satisfactory substitute for high-energy gamma emitters with a higher therapeutic ratio and allows for better geometric dose distribution with a low dose rate irradiation.

Dr. Luis Delclos discussed the utilization of various techniques in the treatment of squamous cell carcinoma of the oral tongue and floor of the mouth. The various aspects of interstitial radiotherapy alone or in combination with external irradiation were discussed with the importance of computer dosimetry and its relation to the dose distribution. Dr. Delclos pointed out the utilization of external irradiation techniques to cover the lymphatic areas at risk with additional interstitial gamma ray therapy for the local primary.

Dr. Bernard Pierquin presented the various aspects of curietherapy in oncology, with specific emphasis upon radiation at a low dose rate. This would allow for enhancement of the differential effect by equalizing the RBE for well oxygenated and poorly oxygenated tissues. He presented his technique with the utilization of after-loading. This was done utilizing iridium-192 wires. Dr. Pierquin reaffirmed the fact that curietherapy is most effective in the treatment of superficial tumors of the skin, breast, nose and throat, anus, rectum, uterus, and bladder.

Dr. Frank Ellis discussed the treatment of connective tissue sarcoma by combined simultaneous surgery and implantation of radioactive isotopes. This involves the utilization of plastic tubes placed into the womb for the introduction of radioactive isotopes at a later point. Eleven of 32 cases were local recurrences following surgery. Seven of these local recurrences remained cured 5 years after treatment. The success rate in preventing local recurrence by this technique is 88 per cent with a 5 year cure rate of 57 per cent in all cases and 67 per cent in the case of fibrosarcoma.

Dr. David D. Beiler presented the experience of the Geisinger Medical Center on the use of interstitial radiation in the treatment of carcinoma of the faucial arch with 72 patients being treated and followed for two or more years. The over-all 3 year survival without disease was 60 per cent. One-third of the entire group were implanted after preliminary external irradiation with local control rate obtained in at least 75 per cent of the patients. No serious complications occurred in the implanted group and the main advantages of implantation relate to reduction in complications and much reduced xerostomia.

Dr. Karen K. Fu presented the review of a 32 year experience at the University of California in the treatment of carcinoma of the oral tongue using external and interstitial radiotherapy. Two hundred and one cases of squamous cell carcinoma of the oral tongue were treated with 35 per cent being treated with interstitial implant alone or in combination with external irradiation. Twenty-one per cent of the patients received peroral cone irradiation alone or additional external radiotherapy. Dosimetry for the interstitial implant was reconstructed on a retrospective basis and compared with manual calculations using the Patterson and Parker system. Neck lymph node metastases developed in 30 per cent of the initially clinically negative unirradiated necks. Subsequent neck dissection failed to control a significant number of these cases.

Dr. Carlos A. Perez discussed non-randomized comparison of radiation ther-

apy alone and preoperative irradiation combined with radical surgery in the treatment of carcinoma of the tonsil. The preliminary data indicated that excellent local control is obtained by radiation alone in Stage I lesions (100 per cent) and Stage II lesions (70 per cent). The control of cervical lymphadenopathy is approximately 80 per cent for N<sub>1</sub> lesions and 68 per cent for N<sub>2</sub> lesions. Less satisfactory results were observed with Stage III lesions (60 per cent local control) or with large fixed cervical lymph nodes (N<sub>3</sub>) in which the control rate was approximately 40 per cent. Preoperative irradiation has not shown comparable results in the treatment of early lesions, but appeared to be as effective as irradiation alone in local control and survival in the patients with more advanced lesions (T<sub>3</sub>  $-N_3$ ).

Dr. Theodore Lo discussed combined therapy in advanced carcinoma of the oral cavity and oropharynx, a randomized study, carried out at the University of Wisconsin. One hundred and thirty-six patients were studied out of 163 patients seen. Lesions of the anterior two-thirds of the tongue, oropharyngeal lesions, floor of the mouth, and tonsil were studied. The initial results reported in 1971 indicated that the 5 year survival rates with combined therapy were significantly superior for oral cavity lesions and, possibly, superior for oropharyngeal lesions. The report updated the study.

Dr. Maurice Greenberg presented the initial evaluation of reduced fractionation in the irradiation of malignant epithelial tumors studied in 170 patients seen at the Milwaukee County General Hospital and the Wood Veterans Administration Hospital. Various fractionation and protraction schedules were utilized. Carcinomas of the skin, breast, and lung were studied.

Dr. L. J. Shukovsky reviewed the experience of twice-daily fractionation in clinical radiotherapy where 6,000 to 7,000 rads were given at the rate of 1,100 to 1,150 rads per week with 2 fractions each day with an 8 hour separation for 5 fractions per

week. Forty patients were treated by this fractionation schedule. The approach produced good local control rates comparable to those that had been achieved by other techniques.

Dr. William A. Walter, Jr. discussed the extramural programs of the National Cancer Institute. He discussed the various aspects of the activities of the Division of Cancer Research, Resources and Centers including the regular grants, clinical trials, studies in life islands, leukemia, scientific evaluation, cancer control, organ site programs, centers, and cancer education. He pointed out that in fiscal year 1975, 4.25 million dollars was being set aside for the radiation therapy development including efforts toward the D/T generator, proton therapy development, clinical hyperthermia, neutron biology computers, axial tomography, stripped ions, etc. He also reviewed the support that had been given in the past to the training of physicians in radiation oncology.

The Fifth Scientific Session dealt with multidisciplined approaches in the management of T<sub>3</sub> and T<sub>4</sub> lesions of the head and neck.

Dr. Million discussed the therapeutic decisions for patients with advanced squamous cell carcinomas of the larynx and hypopharynx, discussing the advantages of surgery followed by postoperative irradiation as compared with preoperative irradiation. The advantages of radiation therapy postoperatively administered related to a reduction in acute surgical morbidity, allowance for the surgeon to visualize the gross tumor margins without having to rely on memory, descriptions, and drawings, availability of examination of the pathological specimen for use in planning postoperative irradiation, allowance for the utilization of the modality which has the chance for cure by itself and also for higher doses of radiation to be used in the postoperative patient.

Dr. Oscar M. Guillamondegui discussed the surgical treatment of advanced carcinoma of the floor of the mouth presenting the rationale for management and the indications for surgery in combination with radiation therapy.

Dr. Frederick Eilber discussed immunotherapy in advanced lesions of the head and neck presenting the utilization of various tests for delayed hypersensitivity and how they might be used in predicting efficacy of treatment as well as the usefulness of BCG and C-Parvum in the treatment of advanced lesions of the head and neck. Ten patients with advanced T<sub>3</sub>, T<sub>4</sub>, N<sub>2</sub> squamous cell carcinomas of the head and neck had been treated with surgery, radiation therapy, and BCG. Four were treated with chemotherapy and BCG with 8 of the 15 remaining free of disease I year following therapy. Dr. Eilber did point out that the role of BCG immunotherapy in these results was not known. It was concluded, however, that immunotherapy is most effective against small numbers (107) of residual tumor cells. Therefore, it is apparent that immunotherapy in advanced head and neck lesions must be employed with other treatment modalities.

Dr. Don R. Goffinet presented the results of megavoltage radiation therapy in oropharyngeal carcinoma treated with curative intent. The records from 87 patients with base of the tongue cancers and 135 with primary tonsillar involvement were studied. Actuarial 5 year survival for those with T<sub>1</sub> and T<sub>2</sub> lesions ranged from 32 to 42 per cent for carcinomas involving the base of the tongue to 62 to 41 per cent for those patients with tonsillar primary cancers. Irradiation of involved cervical lymph nodes led to a local control rate of 60 to 27 per cent for those patients with base of tongue primary neoplasms and N1-N3 nodal involvement, respectively. Twentytwo patients with advanced lesions were entered into a randomized control protocol comparing irradiation, combined radiation therapy and surgery, or surgery alone as the primary treatment and these results were also presented.

Dr. Stefano Stefani discussed immunologic evaluation of patients with lesions of

the head and neck seen on the therapeutic radiology service of the Hines Veterans Administration Hospital. Pre-therapeutic evaluation revealed that 71 per cent responded positively to two-or more recall antigens and 61 per cent positively to DNCB. Post-therapeutic evaluation revealed that of those patients tested, 92 per cent were positive to two or more recall antigens and 62 per cent were positive to DNCB. The proportions of total T-cells and B-cells were evaluated with pretherapy evaluation indicating that 59 per cent had normal T-cells and 75 per cent had normal B-cells. Post radiation therapy evaluation showed a marked change in the proportion of total T-cells with 19 per cent of the patients tested having normal T-cell values while 50 per cent of those tested showed normal B-cell values.

Dr. Joseph Bohorquez discussed the factors that modify the radio-response of cancer of the nasopharynx, indicating that histologic grade, initial site of origin, presenting symptoms, delay between initial complaint and treatment, stage of the tumor, extension of lymph node metastasis, invasion by the primary tumor of adjacent areas, and total tumor dose-time factors were most important in predicting the prognosis.

Dr. S. Rafla-Demetrious discussed the place of radiotherapy in the definitive management of rectal carcinoma, indicating that radiotherapy can be definitive treatment in rectal cancer for both primary and recurrent lesions. He reviewed 103 histologically proven cases with management results. Radiation therapy was capable of sterilizing the disease, whether it was a primary lesion or recurrent, with subsequent long survival. Various radiation therapy plans were used including external beam irradiation and interstitial implantation techniques.

Dr. Omar M. Salazar discussed the proper management of superior vena caval obstruction, indicating that it is a life threatening medical syndrome demanding emergency treatment. Sixty patients treated

by a high daily dose fractionational radiation therapy schedule were presented. The value of serial Tc<sup>99m</sup> angiograms was pointed out. The high dose daily fractionational radiation therapy schedule produced a 90 per cent success rate for relieving the syndrome.

Dr. Robert E. Lee presented a comparison of split-course radiotherapy and continuous radiotherapy for unresectable bronchogenic carcinoma. He indicated that the split course group fared as well as the continuous radiotherapy group when 5 year survival was used as the major criterion. The split course had two primary clinical advantages relating to the fact that the patients tolerated the split course radiotherapy better and, in about one-fifth of these patients, the rest period allowed occult distant metastasis to become manifest and the patient was spared futile additional radiotherapy to the primary lesion.

Dr. Bernard Roswit discussed radiation injuries of the lung, indicating the clinical syndrome with high-risk factors and the guidelines for safer practice.

Dr. William U. Shipley presented a program for enhanced radiation response of small pulmonary metastases of the Lewis lung carcinoma. This is a model that is satisfactory to evaluate the radiosensitivity of "microscopic" or subclinical metastatic tumor deposits. The results indicated that small tumor implants may be sterilized with lower doses than larger primary tumors, not only because fewer cells need to be inactivated, but in addition, the tumor cells in small deposits may be intrinsically more radiosensitive. Thus, these findings may, in part, help to explain and predict the success of regional radiotherapy in controlling subclinical regional deposits of metastatic carcinoma.

Dr. Morton M. Kligerman reviewed the initial comparative response of metastatic superficial nodules surrounding and under-

lying normal tissue to peak pions and x-rays. The studies were begun in October 1974 and ended in December 1974. The purpose was to evaluate the radiobiological effects of pions on skin nodules, normal skin, and underlying connective tissue. This was carried out as an initial step in gathering sufficient human data to begin pilot studies and, ultimately, Phase III clinical trials of pion radiation therapy at Los Alamos.

The Fifty-seventh Annual Meeting of the American Radium Society in Isla Verde, Puerto Rico was an unqualified success. Great credit for its impact belongs to Dr. Victor A. Marcial who was Chairman of the Scientific Program Committee and to Dr. Luis A. Vallecillo who was Chairman of the Arrangements Committee. The social activities were greatly enjoyed by all of the members who attended.

The officers elected for 1975–1976 are as follows: President: Felix N. Rutledge, M.D., Houston, Texas; President-Elect: Luther W. Brady, M.D., Philadelphia, Pennsylvania; First Vice-President: Elliott Strong, M.D., New York, New York; Second Vice-President: Alfred Sherman, M.D., Detroit, Michigan; Secretary: Richard H. Jesse, M.D., Houston, Texas; Treasurer: Fred W. George, III, M.D., Los Angeles, California; Executive Committee: Antolin Raventos, M.D., Chairman, Davis, California; Victor A. Marcial, M.D., San Juan, Puerto Rico; Jerome M. Vaeth, M.D., San Francisco, California.

The Fifty-eighth Annual Meeting of the American Radium Society will be held in Vancouver, British Columbia from May 9 to 14, 1976. The Chairman of the Arrangements Committee will be Dr. J. M. Gibson and the Chairman of the Scientific Program Committee will be Dr. Felix N. Rutledge.

LUTHER W. BRADY, M.D.

Chairman, Publications Committee American Radium Society



## **NEWS ITEMS**

FORTHCOMING EVENT AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE SUMMER SCHOOL

A course on fundamental and basic concepts of dosimetry will be held from July 18-24, 1976 at Trinity College, Burlington, Vermont 05401.

For further information, please write to: Dr. Peter R. Almond, Director, 1976 Summer School, Department of Physics, University of Texas, M. D. Anderson Hospital, Houston, Texas 77025.

# POSTGRADUATE COURSE: THE RADIOLOGY OF TRAUMA

The Department of Radiology of Cornell University and Medical College will sponsor a postgraduate course "The Radiology of Trauma," January 19–22, 1976 in Puerto Rico. This has been approved for 18 hours of AMA Category 1 credit.

For further information, please write to: John A. Evans, M.D., Department of Radiology, Cornell University Medical College, 1300 York Avenue, New York, New York 10021.

#### NEURORADIOLOGY

A course on neuroradiology will be offered November 7 and 8, 1975, in Atlanta, Georgia, sponsored by the Department of Radiology of Emory University School of Medicine.

For further information, please contact: H. Stephen Weens, M.D., Department of Radiology, Emory University School of Medicine, Atlanta, Georgia 30322.

SYMPOSIUM ON MODERN CONCEPTS IN BRAIN TUMOR THERAPY, LABORATORY AND CLINICAL INVESTIGATION

A symposium on modern concepts in brain tumor therapy, laboratory and clinical investigation will be presented on February 26, 27, 28, 1976, in Atlanta, Georgia, sponsored by the Clinical Investigations Branch and the Cancer Clinical Investiga-

tion Review Committee of the National Cancer Institute.

For information, please write to: Audrey E. Evans, M.D., The Children's Hospital of Philadelphia, One Children's Center, 3400 Civic Center Boulevard, Philadelphia, Pennsylvania 19104.

#### FOURTH INTERNATIONAL CONFERENCE, ON MEDICAL PHYSICS

The Fourth International Conference on Medical Physics will be held July 25-30, 1976, in Ottawa, Canada.

The Program Committee invites contributions concerned with basic aspects of physical principles and techniques applied to medical treatment diagnosis and research.

For further information, please write to: Paul M. Pfalzner, Secretary General, Fourth International Conference on Medical Physics, 1053 Carling Avenue, Ottawa, Ontario, Canada.

#### **ANGIOGRAPHY**

The Department of Radiology of Harvard Medical School will sponsor a course on "Angiography: 1975: Coronary Disease, the Myocardium, and Adult Heart Disease." It will be held in Boston, Massachusetts, October 8–11, 1975, under the chairmanship of Herbert L. Abrams, M.D.

This comprehensive course is designed for all physicians who participate in or intend to perform coronary arteriographic studies, ventriculography, and cardiovascular radiology.

It will include lectures, panel presentation, film reading, and evening seminars.

For further information, please contact: Department of Continuing Education, Harvard Medical School, 25 Shattuck Street, Boston, Massachusetts 02115.

IRANIAN RADIOLOGICAL SOCIETY
The Sixth Iranian Congress of Radiology

will be held in Mashad, Iran, May 8-13, 1976.

Papers are invited.

For further information, please contact: Majid Rooholamini, M.D., Secretary, Iranian Radiological Society, P.O. Box 14—1151, Tehran, Iran.

# THE THIRD ROCHESTER SYMPOSIUM ON PLANNING AND OPERATION OF RADIOLOGY DEPARTMENTS

The Third Rochester Symposium on "Planning and Operation of Radiology Departments" will be held October 26 to 29, 1975. It will feature speakers and exhibits.

It will cover planning of space, use of personnel, and aspects of viewing, reporting, storage, retrieval, and finance in a radiologic practice.

For further information, please contact: Harry W. Fischer, M.D., Department of Radiology, University of Rochester Medical Center, Rochester, New York 14642.

#### NEURORADIOLOGY AND OTOLOGY

New York University's Post-Graduate Medical School will offer a comprehensive course in neuroradiology and otology, with a symposium on the temporal bone organized by Dr. R. Thomas Bergeron, professor of Radiology. The course will be held October 27–31, 1975. Drs. Irvin I. Kricheff, Joseph P. Lin, and Ajax J. George will be course co-directors.

This course will present a structured approach to the interpretation of neuroradiologic examinations such as plain films, tomography, angiography, pneumography, myelography and computerized tomography.

The course is approved for 30 hours credit in Category 1 for the Physician's Recognition Award of the American Medical Association.

For further information, please write to: Office of the Associate Dean, New York University Post-Graduate Medical School, 550 First Avenue, New York, New York 10016.

#### **GENITOURINARY RADIOLOGY**

UCLA Extension's Department of Health Sciences will present "Modern G.U. Radiology—The Practical Approach" (The Ninth Annual Leo G. Rigler Symposium), Friday to Sunday, November 7 to 9, 1975 at the Beverly Hilton Hotel in Beverly Hills, California.

For additional information, please write to: Health Sciences, UCLA Extension, P.O. Box 24902, Los Angeles, California 90024, or call (213) 825-7186.

### PEDIATRIC AND ADOLESCENT ECHO-CARDIOGRAPHY COURSE

The Department of Pediatrics, University of Arizona, will present a didactic and practical course in one- and two-dimensional pediatric echocardiography, November 14–16, 1975.

For further information, please contact: S. J. Goldberg, Department of Pediatrics, University of Arizona School of Medicine, Tucson, Arizona 85724.

# ARTHROGRAPHY COURSE AND WORKSHOP

An Arthrography Course and Workshop will be offered on December 11, 12 and 13, 1975, with 16 hours Category 1 credit, at the Hospital for Special Surgery, 535 East 70th Street, New York, New York 10021.

For further information, please contact: Robert H. Freiberger, M.D., Director, Department of Radiology, Hospital for Special Surgery, 535 East 70th Street, New York, New York 10021.

#### 29TH INDIAN CONGRESS OF RADIOLOGY

The 29th Annual Congress of the Indian Radiological Association will be held at Madras, South India, on the 9th, 10th and 11th of January 1976. The scientific session will be preceded by a one day teaching seminar. Members of the Radiological Societies are invited to attend and participate in the Congress.

Inquiries may be addressed to: Dr. G. Munuswamy, Organising Secretary, Bar-

nard Institute of Radiology and Cancer, Government General Hospital, Madras 600 003, South India.

ANNUAL TWO-DAY POSTGRADUATE CON-FERENCE ON CURRENT CONCEPTS IN DIAGNOSTIC AND THERAPEUTIC APPROACHES

The Oncology Center of the Johns Hopkins Medical Institutions announces a course entitled "Diagnosis and Treatment of Neoplastic Disorders," an annual two-day postgraduate conference on current concepts in diagnostic and therapeutic approaches to patients with neoplastic diseases. This conference is designed for the practicing physician and will emphasize treatment. This course has been approved for 17 hours Category 1 accreditation.

The course will be held at the Johns Hopkins University School of Medicine, February 5–6, 1976. For information and application, please write to: Program Coordinator, Turner Auditorium, Room 17, 720 Rutland Avenue, Baltimore, Maryland 21205.

#### **ANGIOGRAPHY**

The Society for Cardiovascular Radiology is sponsoring a four day postgraduate course in angiography on February 17–20, 1976, in Puerto Rico.

Current concepts of diagnosis and therapeutic uses of angiography will be presented covering the techniques, diagnostic findings, interpretation, potential complications, advantages and limitations of the different procedures.

The course has been accredited by the American College of Radiology for 25 hours of AMA Category 1 credit.

Inquiries should be addressed to: C. A. Athanasoulis, M.D., Department of Radiology, Massachusetts General Hospital, Fruit Street, Boston, Massachusetts 02114.

# REFRESHER COURSE IN GENERAL DIAGNOSTIC RADIOLOGY

The Department of Radiology of The University of Texas Southwestern Medical School at Dallas announces a Refresher Course in General Diagnostic Radiology to be held at the Fairmont Hotel, Ross at Ackard, Dallas, Texas, February 19–21, 1976.

This Continuing Medical Education offering meets the criteria for 18 hours of credit in Category 1 for the Physician's Recognition Award of the American Medical Association.

The course subject matter will include all phases of general radiology, as well as nuclear medicine, ultrasound, radiation biology, physics and a course in department planning.

For further information, please contact: Ms. June Bovill, Continuing Education, The University of Texas Health Science Center at Dallas, 5323 Harry Hines Boulevard, Dallas, Texas 75235.

#### FOURTH ANNUAL SYMPOSIUM ON PRACTICAL ADVANCES IN DIAG-NOSTIC RADIOLOGY AND NUCLEAR MEDICINE

The Johns Hopkins Medical Institutions will present its Fourth Annual Symposium on Practical Advances in Diagnostic Radiology and Nuclear Medicine on March 23–26, 1976. The course is a review of current advances with emphasis on modern techniques, recently developed procedures, new clinical concepts, and diagnostic equipment. Presentations will be directed at the practicing radiologist.

The program is approved for 32 hours of Category 1 American Medical Association credit.

For further information, please contact: Janet B. Hardy, M.D., Room 17, Turner Auditorium, The Johns Hopkins Hospital, Baltimore, Maryland 21205.

#### COMPUTERIZED TOMOGRAPHY

An International Symposium and Course on computerized tomography will be held at the Caribe Hotel, in San Juan Puerto Rico, from April 4–9, 1976, under the sponsorship of Juan M. Taveras, M.D., and Paul F. J. New, M.D.

The symposium will emphasize informal

open discussions between members of the faculty, with audience participation.

The course will consist of a comprehensive series of lectures. A Physics Program will be included.

Those wishing to present papers should submit 100 to 200 word abstracts to: Juan M. Taveras, M.D., Program Director, Department of Radiology, Massachusetts General Hospital, Boston, Massachusetts 02114.

For further information, please write to: Mrs. Susan Lincoln, Department of Radiology, Massachusetts General Hospital, Boston, Massachusetts 02114.

### PATHOLOGY OF BONE AND JOINTS

The second postgraduate course on Pathology of Bone and Joints will be presented from April 12 to April 16, 1976 under the direction of Howard D. Dorfman, M.D., at the Johns Hopkins Medical Institutions.

Structure, development, and function of the skeletal and articular systems are discussed in relation to developmental, inflammatory, metabolic, and neoplastic disorders.

This course has been approved for 50 credit hours in Category 1 towards the Physician's Recognition Award of the American Medical Association. Apply to: Office of Continuing Education, Turner Building, Room 17, 720 Rutland Avenue, Baltimore, Maryland 21205.

#### MEDICAL IMAGES: FORMATION, PERCEPTION AND MEASUREMENT

The seventh L. H. Gray conference, which will be concerned with the fundamentals of medical images, will be held at the University of Leeds, England on April 13th-15th, 1976. The purpose of the conference is to concentrate attention on the unifying principles which underline the

variety of imaging techniques now used in medicine.

There will be an exhibition of imaging devices.

For further information, please write to: M. J. Day, Regional Medical Physics Department, Newcastle General Hospital, Newcastle upon Tyne, NE<sub>4</sub> 6BE, England.

#### INTERNATIONAL SYMPOSIUM ON CALIFORNIUM-252 UTILIZATION

Papers are invited for the International Symposium on Californium-252 Utilization to be held April 22-24, 1976, in Brussels, Belgium, and April 26-28, 1976, in Paris, France.

It is sponsored by the American Nuclear Society, the European Nuclear Society, the Belgian and the French Sections of the American Nuclear Society.

For further information on the Brussels Symposium, please contact: Prof. D. J. Mewissen, Service de Radiobiologie, Université Libre de Bruxelles, boulevard de Waterloo, 109, 1000-Bruxelles, Belgique. For the Paris Symposium, please contact: Dr. Réne Berger, Service d'Hydrométallurgie et de Chimie des Transuraniens, Centre d'Etudes Nucléaires B.P. n° 6, 92260—Fontenay-aux-Roses, France.

#### GENERAL DIAGNOSTIC RADIOLOGY

The University of British Columbia Department of Diagnostic Radiology is to hold a Refresher Course in General Diagnostic Radiology, sponsored by the University of British Columbia, May 19th, 20th and 21st, 1976 in Vancouver, British Columbia, Canada at the Bayshore Inn.

Additional information may be obtained from: D. Gordon Garrow, M.D., Department of Diagnostic Radiology, 10th Avenue and Heather Street, Vancouver, British Columbia, Canada V5Z 1Mo.



## **BOOK REVIEWS**

ABDOMINAL ANGIOGRAPHY. By W. Wenz, in collaboration with G. van Kaick, D. Beduhn, and F.-J. Roth. Cloth. Pp. 217, with 183 figures. Price, \$27.80. Springer-Verlag New York Inc., 175 Fifth Avenue, New York, N. Y. 10010, 1974.

Four European authors present their combined experience with abdominal angiography in almost 3,000 patients. The book is small and is structured into 4 sections: text, illustrations,

bibliography, and subject index.

The textual material covers all phases of abdominal angiography except that of the genitourinary tract, including historical comments, some vascular anatomy, indications and complications of abdominal angiography, and the methods for performing the angiographic examinations needed to help in the diagnosis of diseases of the abdominal organs. Each of the 6 chapters in the text is divided into many related topics, each numbered in a ponderous if not superfluous decimal-like system. Charts and tables appear in the text, but without number designations, making it difficult sometimes to connect the figures with the appropriate textual reference.

On the whole, the authors give a balanced presentation of abdominal venous and arterial angiography and involved techniques such as pharmaco-angiography, subtraction, color x-rays, etc. Adequate space is devoted to discussing separately each specific abdominal organ, covering conventional as well as angiographic techniques in their examination.

The book is compact, but it is made so at the expense of placing all the illustrations in a separate inconvenient section at the back of the book. Here the authors have introduced a small number of colored x-rays and colored subtraction angiographies, in addition to the many ordinary black and white illustrations. Unfortunately, most of the illustrations are too small. Often as many as 9 figures have been crowded onto a single page.

The book contains much worthwhile information, but its format and style made it difficult for this reviewer to read. The bibliography is extensive; many of the references are in foreign journals. The book could perhaps be of use to physicians interested in comparing a large

European experience in abdominal angiography with that of domestic angiographers. Otherwise, the book offers little that one cannot obtain more easily from any of several U.S. books on abdominal angiography.

A. J. Palubinskas, M.D.

GAMUTS IN RADIOLOGY: COMPREHENSIVE LISTS of Roentgen Differential Diagnosis. By Maurice M. Reeder, M.D., Colonel, Medical Corps, United States Army; Chief, Department of Radiology, Walter Reed Army Medical Center, and Radiology Consultant to the Surgeon General, United States Army, Washington, D. C.; formerly, Associate Radiologist, Registry of Radiologic Pathology, Armed Forces Institute of Pathology; and Benjamin Felson, M.D., Professor, Department of Radiology, University of Cincinnati College of Medicine and Medical Center; Consultant to Cincinnati and Dayton Veterans Administration Hospitals; National Consultant to the Medical Corps of the United States Air Force, Army, Navy, and Veterans Administration, United States Public Health Service, Armed Forces Institute of Pathology, and Walter Reed General Hospital. With contributions by Elias G. Theros, M.D., Herbert E. Parks, M.D., and George B. Greenfield, M.D. Cloth. Divided into 8 Sections. Audiovisual Radiology of Cincinnati, Inc., P. O. Box 8942, Cincinnati, Ohio 45208, 1975.

If the radiologist does not *think* of a diagnosis, he cannot *make* that diagnosis. This volume helps him think of the diagnosis.

This book is a compilation of lists of possible diseases, arranged according to a presenting roentgen abnormality. Some possibilities are not the first to come to mind. For example, under the heading "Gas in the portal vein" there are 8 possibilities listed, among them, hydrogen peroxide enema; among the 7 causes of unilateral small kidney is irradiation therapy. The book is divided into 8 large sections, each with its own table of contents, and the organization makes an index unnecessary and superfluous. In each section is a large number of individual roentgen characteristics, or findings, and under each of these headings is a list of the

possible causes for this abnormality, arranged alphabetically, and separated into common and uncommon causes.

In a way, this is software for a computer. It is directed toward that computer which, in the words of William S. Reveno, M.D., is the only computer which can be mass produced by unskilled labor—the human brain. The idea of such lists or gamuts is probably polygenetic, but it has been recently spread, through occasional notes in the Journal of the American Medical Association, and gamut cards have been available from the Registry of Radiologic Pathology of the Armed Forces Institute of Pathology. This book is a large compilation of these lists, from many sources.

The publishers have properly prepared for hard use of the book, and it is sturdily bound. Space is provided for amplifying the lists, to adapt them to the user's geographic situation or patient sample. In a department where each patient's films are examined simultaneously by a panel of 20 to 30 experienced radiologists, this book might not be necessary. In a realistic situation, where fewer radiologists see the films, the book is a vital necessity—as the authors say, an "unobtrusive consultant."

E. Frederick Lang, M.D.

#### BOOKS RECEIVED

A TEXTBOOK OF RADIOLOGY. Second edition. Edited by David Sutton, M.D., F.R.C.P., F.F.R., M.C.A.R. (Hon.), Director, Radiological Department, St. Mary's Hospital, London; Consultant Radiologist, Maida Vale Hospital (the National Hospitals for Nervous Disease), London; Teacher in Radiology, St. Mary's Hospital Medical School, University of London, and Institute of Neurology, University of London; Assisted by Ronald G. Grainger, M.D., F.R.C.P., D.M.R.D., F.F.R., Consultant Radiologist to United Sheffield Hospitals; Consultant Radiologist in Charge, Northern General Hospital, Sheffield; Consultant Radiologist to Sheffield Cardio-Thoracic Centre, Sheffield; Clinical Teacher in Radiology, University of Sheffield. Cloth. Pp. 1,1376, with many illustrations. Price, \$79.50. Churchill Livingstone, Edinburgh, London and New York. Longman Inc., 72 Fifth Avenue, New York, N. Y. 10011, 1975.

RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYSICS, BIOLOGY, AND PROTECTION. By Stewart C. Bushong, Sc.D., Associate Professor of Radiologic Science, Baylor College of Medicine, Houston, Texas. Cloth. Pp. 343, with 317 illustrations. Price, \$13.50. C. V. Mosby Company, Publishers, 3301 Washington Boulevard, St. Louis, Mo. 63103, 1975.

Familial Polyposis Coli: Family Studies, Histopathology, Differential Diagnosis, and Results of Treatment. By H. J. R. Bussey. Cloth. Pp. 104, with many illustrations. Price, \$12.00. The Johns Hopkins University Press, Baltimore, Md. 21218, 1975.

ATLAS OF LYMPHOGRAPHY. By Dr. T. de Roo, Radiologist, Central Hospital, Alkmaar, The Netherlands. With a foreword by Prof. Dr. A. Rüttimann, Radiologist, Stadtspital Triemli, Zürich, Switzerland. Cloth. Pp. 190, with 9 illustrations in color, and 378 illustrations in black and white. Price, \$42.00. J. B. Lippincott Company, East Washington Square, Philadelphia, Pa. 19105, 1975.

THE BIOLOGY AND CLINICAL MANAGEMENT OF BLADDER CANCER. Edited by E. H. Cooper, M.D., D.Sc., D. Phil., F.R.C.P., Mackintosh Professor of Experimental Pathology and Cancer Research, University of Leeds; and R. E. Williams, M.D., Ch.M., F.R.C.S.E., Consultant Urologist, General Infirmary at Leeds, England. Cloth. Pp. 293, with 52 illustrations. Price, \$38.75. Blackwell Scientific Publications, Oxford, London, Edinburgh, and Melbourne. J. B. Lippincott Company, East Washington Square, Philadelphia, Pa. 19105, 1975.

DIAGNOSTIC RADIOGRAPHY: A CONCISE PRACTICAL MANUAL. Second edition. By Glenda J. Bryan, D.S.R., S.R.R., Superintendent Radiographer, Bristol Royal Hospitals. With a foreword by J. H. Middlemiss, C.M.G., M.D., F.R.C.P., F.F.R., Professor of Radiology, University of Bristol, England. Paper. Pp. 356, with some figures. Price, \$13.00. Churchill Livingstone, Edinburgh and London. Longman Inc., 72 Fifth Avenue, New York, N. Y. 10011, 1974.

COMMUNITY HEALTH NURSING. Report of a WHO Expert Committee. World Health Organization Technical Report Series No. 558. Paper. Pp. 28. Price, Sw.fr. 4.—. Q Corporation, 49 Sheridan Avenue, Albany, N. Y. 12210, 1974.

RADIATION SCIENCE AT THE NATIONAL PHYSICAL LABORATORY, 1912–1955. By E. E. Smith, B.Sc., M.Inst.P. Paper. Pp. 114. Price, £5. Her Majesty's Stationery Office, London, 1975.

ELEMENTS OF RADIATION PROTECTION. By Ronald V. Scheele, B.S., M.S., Radiation Physicist; Assistant Professor of Radiology (Radiologic Physics), University of Virginia School of Medicine, Charlottesville, Va.; and Jack Wakley, B.Sc., Director, Radiation Physics Division; Assistant Professor of Radiology (Radiologic Physics), University of Virginia School of Medicine, Charlottesville, Va. Paper. Pp. 99, with some figures. Price, \$7.95. Charles C Thomas, Publisher, 301–327 East Lawrence Avenue, Springfield, Ill. 62717, 1975.

CARCINOGENESIS AND RADIATION RISK: A BIO-MATHEMATICAL RECONNAISSANCE. By W. V. Mayneord, C.B.E., D.Sc., F.R.S., Professor Emeritus of Physics as applied to Medicine, Institute of Cancer Research (University of London); Consultant to the Central Electricity Generating Board; and R. H. Clarke, Ph.D., Central Electricity Generating Board, Research Department, Berkeley Nuclear Laboratories, Berkeley, Gloucestershire, England. British Journal of Radiology, Supplement No. 12. Paper. Pp. 112, with some figures. Published by the British Institute of Radiology, 32 Welbeck Street, London WIM 7PG, England, 1975.

Host Defence in Breast Cancer. Volume 1 in the Series, New Aspects of Breast Cancer. Edited by Basil A. Stoll, Honorary Consultant Physician to the Radiotherapy Department at St. Thomas' Hospital and the Royal Free Hospital, London, England. Cloth. Pp. 206, with some figures. Price, \$13.95. A William Heinemann Medical Books Publication. Distributed by Year Book Medical Publishers, Inc., 35 East Wacker Drive, Chicago, Ill. 60601, 1974.

ROENTGEN APPEARANCE OF THE HAND IN DIFFUSE DISEASE. By Howard L. Steinbach, M.D., Chief of Radiology, French Hospital, San Francisco; Clinical Professor of Radiology and Medicine, University of California, San Francisco Medical Center; Clinical Professor of Radiology, Stanford University School of Medicine, Stanford, Calif.; Richard H. Gold, M.D., Associate Professor of Radiological Sciences; Chief, Orthopedic Radiology Section, University of California, Los Angeles Center for the Health Sciences; and Leslie Preger, M.B., Ch.B., F.R.C.R., D.Obst. R.C.O.G., F.F.R.R.C.S. (IREL.), Assistant Chief of Radiology, French Hospital, San Francisco; Associate Clinical Professor of Radiology, University of California, San Francisco Medical Center. Cloth. Pp. 528, with 401 figures. Price, \$47.75. Year Book Medical Publishers, Inc., 35 East Wacker Drive, Chicago, Ill. 60601, 1975.



## SOCIETY PROCEEDINGS

### MEETINGS OF RADIOLOGICAL SOCIETIES\*

#### United States of America

AMERICAN ROENTGEN RAY SOCIETY

MERICAN ROENTGEN RAT SOCIETY
Secretary, Dr. James Franklin Martin, 300 S. Hawthorne Rd., Winston-Salem, N. C. 27103. Annual Meeting: Marriott Hotel; Atlanta, Ga., Sept. 30–Oct. 3, 1975. AMERICAN RADIUM SOCIETY

MERICAN RADIOM SOCIETY
Secretary, Richard H. Jesse, Dept. of Surgery, M. D.
Anderson Hosp. and Tumor Institute, Houston, Tex.
77025. Annual Meeting: Vancouver, B. C., Canada,
May 9-14, 1976.

RADIOLOGICAL SOCIETY OF NORTH AMERICA Secretary, Dr. Theodore A. Tristan, Harrisburg, Pennsylvania. Annual Meeting: McCormick Place on the Lake,

Chicago, Ill., Nov. 30-Dec. 5, 1975.

AMERICAN COLLEGE OF RADIOLOGY

Executive Director, William C. Stronach, 20 N. Wacker Drive, Chicago, Ill. 60606. Annual meeting.

Section on Radiology, American Medical Association Secretary, Dr. Antolin Raventos, Davis, Calif. Annual Meeting.

AMERICAN BOARD OF RADIOLOGY

Secretary, Dr. C. Allen Good. Correspondence should be directed to Kahler East, Rochester, Minn. 55901.
Written Examination will be held in 14 selected sites,

June 21, 1975

Oral examinations will be held: Pittsburgh Hilton, Pittsburgh, Pa., June 2-7, 1975; Statler Hilton, Dallas, Texas, Dec. 8-13, 1975; Marriott Motor Hotel, Chicago, Ill., June 14-19, 1976; Sheraton Biltmore, Atlanta, Ga., Dec. 6-11, 1976.

Applications must be received in the Board Office before Sept. 30 of the year preceding the one in which the candidate wishes to be examined.

Deadline for filing applications for any examination in

1976 is September 30, 1975.

AMERICAN BOARD OF NUCLEAR MEDICINE, INC. A Conjoint Board of the American Boards of Internal Medicine, Pathology and Radiology and sponsored by the Society of Nuclear Medicine.

Application forms and further information are available from the American Board of Nuclear Medicine, 305 E. 45th St., New York, N. Y. 10017.

American Association of Physicists in Medicine Secretary, Dr. Robert G. Waggener, Dept. Radiol., Univ. Tex. Health Sciences Center, San Antonio, Tex. 78284. Annual Meeting, Aug. 3-7, 1975.

American Society of Therapeutic Radiologists

Secretary, Dr. Robert W. Edland, 1836 South Ave., La

Crosse, Wis., 54601. Annual Meeting: Hyatt Regency
Hotel in the Embarcadero Center, San Francisco, Calif., Oct. 8-12, 1975.
AMERICAN NUCLEAR SOCIETY

Program Chairman, Werner K. Kern, IRD, Space Nuclear Systems, F 309, U. S. Atomic Energy Commis-sion, Washington, D.C. 20545.

AMERICAN INSTITUTE OF ULTRASOUND IN MEDICINE Secretary, John M. Reid, Ph.D., 556 18th Ave., Seattle, Wash. 98122. Annual Meeting.

AMERICAN SOCIETY OF NEURORADIOLOGY Secretary, Dr. David O. Davis, Department of Radiology, 901 Twenty-third St., N.W., Washington, D. C. 20037. Annual Meeting.

FOURTEENTH INTERNATIONAL CONGRESS OF RADIOLOGY Rio de Janeiro, Brazil, Oct. 23-29, 1977.

President Elect: Prof. Dr. Nicola C. Caminha; General Secretary: Dr. Durval Couto. Av. Churchill, 97-50 and LC-39 20,000 Rio de Janeiro, Brazil.

INTERNATIONAL SOCIETY OF RADIOLOGY

Hon. Secretary-Treasurer, Prof. W. A. Fuchs, M.D., Department of Diagnostic Radiology, University Hospital, Landwick CH. 200 Pages Switzgeland.

Inselspital, CH-3010 Bern, Switzerland.

Tweifth Inter-American Congress of Radiology

President, Dr. Public Vargas Pazzos, Casilla 5227,
Guayaquil, Ecuador. Meeting in Quito, Ecuador, 1979.

Inter-American College of Radiology

President, Manuel Viamonte, Jr., M.D., Mt. Sinai Medical Center, 4300 Alton Rd., Miami Beach, Fla. 33140. Secretary, Gaston Morillo, M.D., Jackson Memorial Hosp., 1700 N.W. 10th Ave., Miami, Fla. 33152. Counselor for the United States, J. A. del Regato, M.D., Univ. of So. Fla. College of Medicine, 13000 No. 30th St., Tampa, Fla. 33612.
Third Congress of the European Association of

RADIOLOGY

Secretary-General, P.O. Box 14, 79 Lauriston Place, Edinburgh BHI IDB, Scotland.

Second Asian and Oceanian Congress of Radiology Secretary, Dr. Buenaventura U. V. Angtuaco, Congress Secretariat Headquarters, 2161 Taft Ave., Manila, Philippines, Meeting: Manila, Philippines, Nov. 10–14, 1975.

Alabama Chapter of ACR

Secretary-Treasurer, Dr. Lawrence E. Fetterman, 1720 Springhill Ave., Suite 201, Mobile, Ala. 36604. Meets time and place of Alabama State Medical Association.

ALASKA RADIOLOGICAL SOCIETY, CHAPTER ACR Secretary-Treasurer, Dr. Maurice J. Coyle, 3200 Provi-

dence Ave., Anchorage, Alaska 99504.

American Osteopathic College of Radiology
Annual Scientific Meeting: Americana Hotel, Bar Harbor, Fla. Program Administrator: Lawrence J. Jordan, D.O., Suite 21, Ponce American Bldg., 4601 Ponce de Leon Blvd., Coral Gables, Fla. 33146.

American Thermographic Society

Secretary-Treasurer, John Wallace, Ph.D., Dept. Radiol., Thomas Jefferson Univ. Hosp., Philadelphia, Pa. 19107. Annual Meeting.

ARIZONA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Irwin M. Freundlich, 1501 N. Campbell Ave., Dept. Radiol., Tucson, 85724. Two regular meetings a year. Annual meeting at time and place of State Medical Association and interim meeting six months

ARK-LA-TEX RADIOLOGICAL SOCIETY Secretary, Dr. Erich K. Lang, Confederate Memorial Medical Center, LSU School of Medicine, Shreveport,

La. 71101. Arkansas Chapter of ACR Secretary-Treasurer, Dr. David H. Newbern, 4301 W. Markham, Little Rock, Ark. 72205. Meets twice annually, the Spring Meeting being in conjunction with and at the place of the State Medical Association.

Association of University Radiologists

Secretary-Treasurer, Dr. Arch W. Templeton, Univ. of
Kansas Med. Center, 39th and Rainbow Blvd., Kansas
City, Kansas 66103. Annual Meeting.

ATLANTA RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Marshall J. Cantanzaro, Dept. of Radiol., Northside Hosp., Atlanta, Ga. 30342. Meets on fourth Thursday evenings during the academic year at a

<sup>\*</sup> Secretaries of societies are requested to send timely information promptly to the Editor.

time announced in early September of each year, at the Academy of Medicine, Atlanta, Ga., at 8:00 P.M.

BAVARIAN-AMERICAN RADIOLOGIC SOCIETY

Secretary, Maj. Marco J. DiBiase, M.D., Radiology Service, 130 Station Hosp., APO N. Y. 09102. Next Meeting: Berlin, March 14-16, 1975.

BLOCKLEY RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. William H. Green, 616 East 24th

St., Chester, Pa. 19013.
BLUEGRASS RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Eugene Slusher, Lexington Clinic, 1221 S. Broadway, Lexington, Ky. 40504. The Society meets once each month during the school year. BRONX RADIOLOGICAL SOCIETY, NEW YORK STATE, CHAP-

TER ACR

Secretary-Treasurer, Dr. Leon J. Corbin, 1369 Rosendale Ave., Bronx, N. Y. 10472. Meets 4 times a year.

BROOKLYN RADIOLOGICAL SOCIETY

Ave., Brooklyn, N. Y. 11209. Meets first Thursday of each month, October through June.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. George J. Alker, Jr., E. J. Meyer Mem. Hosp., Buffalo, N. Y. 14215. Meets second Monday evening each month, October to May inclusive, at University Club.

CALIFORNIA RADIATION THERAPY ASSOCIATION

Secretary-Treasurer, Dr. Duane J. Gillum, Stanford Medical Center, Stanford, Calif. 94304. Meets semiannually in San Francisco and Los Angeles.

CALIFORNIA RADIOLOGICAL SOCIETY, CALIFORNIA CHAPTER

OF ACR

Secretary-Treasurer, Dr. John L. Gwinn, 4650 Sunset Blvd., Los Angeles, Calif. 90027.

CATAWBA VALLEY RADIOLOGICAL SOCIETY

Secretary, Dr. Walter Joe Jacumin, P.O. Box 265, Rutherford College, N. C. 28671. Meets the last Thurs-day of every month, Holiday Inn, Morganton, N. C. at 7:30 P.M.

CENTRAL NEW YORK RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Alfred Brettner, Auburn Mem. Hosp., Auburn, N. Y. 13021. Meets first Monday each month October through May.

CENTRAL OHIO RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Daniel E. Lewis, 309 East State St., Columbus, Ohio 43215. Meets second Thursday in October, November, January, March, and May at Fort Hayes Hotel, Columbus, Ohio.

CENTRAL TEXAS RADIOLOGY SOCIETY

Secretary-Treasurer Dr. E. Jerome Schoolar, Scott and White Clinic, Temple, Tex. 76501. Meets the fourth Monday of each month at Ponderosa Hotel, Temple, Tex. at 7:00 P.M.

CHICAGO RADIOLOGICAL SOCIETY, DIVISION OF THE ILLINOIS RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Harold J. Lasky, 55 E. Washington St., Suite 1735, Chicago, Ill. 60602. Meets third Thursday of each month, October to April, except December, at the Bismark Hotel, Chicago, Ill.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Charles M. Greenwald, 7007 Powers Blvd., X-Ray Dept., Parma, Ohio 44129. Meetings at 7:00 P.M. on fourth Monday of October, November, January, February, March and fifth Monday of April.

COLORADO RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. John Pettigrew, Denver, Colo. Meets third Friday of each month at Denver Athletic Club from September through May.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY
Secretary, Dr. Gerald N. LaPierre, 759 Chestnut St.,
Springfield, Mass. 01107. Meets in April and October.

DALLAS FORT WORTH RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Robert R. Burns, 1400 Stemmons Ave., Dallas, Tex. 75208. Meets the 3rd Monday

of every month at 6:30 P.M., at the Airport Hotel, Arling-

DELAWARE CHAPTER OF ACR

Secretary, Dr. Seymour R. Kaplan, Kent Gen. Hosp., Dover, Del. 19901.

EAST BAY RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Robert L. Stein, 43 Dormidera Ave., Piedmont, Calif. 94611. Meets first Thursday each month, Oct. through May, at University Club, Oakland,

EAST TENNESSEE RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. George H. Wood, 205 Medical Arts Bldg., Knoxville, Tenn. 37902. Meets in January and September.

FLORIDA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary. Dr. Paul J. Popovich, 1350 S. Hickory St., Melbourne, Fla. 32901. Meets twice annually, in the spring with the Annual State Society Meeting and in the fall.

FLORIDA WEST COAST RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Herbert Johnson, Davis Blvd., Tampa, Fla. 33606. Meets on 4th Thursday of the months January, March, May, October, and November.

GEORGIA RADIOLOGICAL SOCIETY, CHAPTER OF ACR
Secretary, Dr. E. P. Rasmussen, Piedmont Prof. Bldg., 35
Collier Rd., N.W., Atlanta, Ga. 30309.

GREATER CINCINNATI RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Owen L. Brown, 2421 Auburn Ave., Cincinnati, Ohio 45219.

GREATER KANSAS CITY RADIOLOGICAL SOCIETY

President-Secretary, Dr. Jay I. Rozen, Suite 216, 6400 Prospect, Kansas City, Mo. 64132. Meets 5 times a year.

GREATER LOUISVILLE RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. L. D. LeNeave, 315 E. Broadway, Louisville, Ky. 40202. Meets monthly.

GREATER MIAMI RADIOLOGICAL SOCIETY Secretary, Dr. David C. Hillman, P. O. Box 610544, North Miami, Fla. 33161. Meets monthly, third Wednesday at 8:00 P.M. at various member hospitals, Miami, Fla.

GREATER ST. LOUIS SOCIETY OF RADIOLOGISTS

GREATER ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary-Treasurer, Dr. Donald Callahan, Northland
Med. Bldg., Jennings, Mo. 63136.

HAWAII RADIOLOGICAL SOCIETY, CHAPTER OF ACR

Secretary-Treasurer, Dr. Sidney B. W. Wong, Straub
Clinic and Hosp., Honolulu, Hawaii 96813. Meets third

Monday of each month at 7:30 P.M.

HEALTH PHYSICS SOCIETY

Secretary, Russell F. Cowing, P.O. Box 156, E. Weymouth, Mass. 02189. Annual Meeting.

HOUSTON RADIOLOGICAL SOCIETY

Secretary, Dr. Neill B. Longley, 6436 Fannin, Suite 601, Houston, Tex. 77025. Meets fourth Monday of each month, except June, July, August and December, at 6:00 P.M., at 103 Jesse H. Jones Library Building, Texas Medical Center, Houston, Tex. 77025

IDAHO STATE RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. John H. Truksa, 1605 Park Ave.,

Nampa, Id. 83651. Meets in the spring and fall.

ILLINOIS RADIOLOGICAL SOCIETY, INC., CHAPTER OF ACR
Secretary, Dr. Robert D. Dooley, Hinsdale Med. Center, Hinsdale, Ill. 60521. Meets in the spring and fall.

Indiana Roentgen Society, Inc., Chapter of ACR. Secretary, Dr. John A. Knote, Home Hosp., Lafayette,

Ind. 47902.

Iowa Radiological Society, Chapter of ACR Secretary-Treasurer, Dr. Dale L. Roberson, 1948 First Ave., NE, Cedar Rapids, Iowa 52402. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific session is held in the

KANSAS RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Ralph H. Baehr, 310 Medical Arts Bldg., Topeka, Kan. 66604. Meets in spring with State Medical Society and in winter on call.

KENTUCKY CHAPTER OF ACR Secretary-Treasurer, Dr. Bernard Sams, St. Joseph Infirmary, 735 Eastern Parkway, Louisvlle, Ky. 40217. Meets in April and September.

KINGS COUNTY RADIOLOGICAL SOCIETY

Secretary, Dr. Sidngy Hendler, 1880 Ocean Ave., Brooklyn 30, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

KNOXVILLE RADIOLOGICAL SOCIETY Secretary, Dr. Clifford L. Walton, Blount Professional Bldg., Knoxville 20, Tenn. Meetings are held the third Monday of every other month at the University of Tennessee Memorial Research Center and Hospital.

LONG ISLAND RADIOLOGICAL SOCIETY Secretary, Dr. Bruce Saxe, 1200 Stewart Ave., Garden City, N. Y. 11533. Meets monthly.

LOS ANGELES RADIOLOGICAL SOCIETY

OS ANGELES RADIOLOGICAL SOCIETY

Secretary, Dr. Isaac Sanders, 1429 Valley View Rd. 13,
Glendale, Calif. 91202. Meets second Wednesday of
month in September, November, January, April and
June at Los Angeles County Medical Association Building, Los Angeles, Calif. Midwinter Radiological Conference. Century Plaza Hotel, Los Angeles, Calif.

LOUISIANA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Roger H. Tutton, 1514 Jeffer-

son Hwy., New Orleans, La. 70121.

LOUISIANA-TEXAS GULF COAST RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Arnold G. Manske, P.O. Box 3008, Port Arthur, Tex. 71670.

MAINE RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Richard W. Taylor, Radiology Department, St. Mary's General Hospital, Lewiston, Maine 04240. Meets in June, September, December and

MARYLAND RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. David S. O'Brien, Anne Arundel Hosp.,

Annapolis, Md. 21401.

MASSACHUSETTS RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Joseph T. Ferrucci, Jr., Massachusetts Gen. Hosp., Boston, Mass. 02114.

MEMPHIS ROENTGEN SOCIETY

Secretary-Treasurer, Dr. Thomas P. Coburn, The University of Tennessee College of Medicine, Department of Radiology, Walter C. Chandler Bldg., 865 Jefferson Ave., Memphis, Tenn. 38163. Meets first Monday Oct. through May at the University Club.

MIAMI VALLEY RADIOLOGICAL SOCIETY
Secretary, Dr. Bert Must, I.B.M. Bldg., Dayton, Ohio.
Meets third Thursday of fall, winter and spring months
at 7:30 P.M. at Miami Valley Hospital, Dayton, Ohio.

MICHIGAN RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Francis P. Shea, Harper Hospital, 3825 Brush St., Detroit, Mich. 48201. Meets monthly, first Thursday, October through May, at David Whitney House, 1010 Antietam, at 6:30 P.M.

MICHIGAN SOCIETY OF THERAPEUTIC RADIOLOGISTS Secretary-Treasurer, Dr. Delmar Mahrt, William Beaumont Hosp., Detroit, Mich. 48072. Meets bi-monthly during the academic year.

MID-HUDSON RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. William D. Stiehm, 37 Flower Hill Rd., Poughkeepsie, N. Y. 12603. Meets 7:00 P.M., first Wednesday of each month, September to May.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary-Treasurer, Dr. Thomas C. Lipscomb, 1004 North Tenth St., Milwaukee, Wis. 53233. Meets monthly on fourth Monday, October through May, at University

MINNESOTA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Marvin E. Goldberg, Box 292, Mayo Memorial Health Sciences Center, Minneapolis, Minn. 55455.

MISSISSIPPI STATE RADIOLOGICAL SOCIETY, CHAPTER OF

Secretary-Treasurer, Dr. Edward L. Gieger, 969 Lakeland Dr., Jackson, Miss. 39216. Meets third Thursday, excluding summer months, at the Primos Northgate Rest., Jackson at 6:30 P.M.

MISSOURI RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Ronald G. Evens, Mallinckrodt Institute of Radiology, 510 S. Kingshighway, St. Louis,

Mo. 63110.

MONTANA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. C. H. Agnew, Room 102, Doctors Bldg., Billings, Mont. 59101. Nebraska Chapter of ACR

Secretary-Treasurer, Dr. Robert Bodmer, Suite 622 Doctors Bdg., Omaha, Neb. 68131. Meets the third Wednesday of the month, Oct. through March, at the Clarkson Hosp., Omaha, Neb. and the fourth Friday of April at the Lincoln Country Club, Lincoln, Neb.

Nevada Radiological Society, Chapter of ACR Secretary, Dr. Charles F. Veverka, Carson Tahoe Hosp., Carson City, Nev. 89701.

N.F. Society For Radiation Oncology

N.E. SOCIETY FOR RADIATION ONCOLOGY Secretary, Dr. C. C. Wang, Mass. Gen. Hosp., Boston, Mass. 02114.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. Melvin E. Clouse, 185 Pilgrim Rd., Boston, Mass. 02115. Meets the third Friday of Oct. and Nov., and third Thurs. of each month. Jan. through May, excluding December, at The Longwood Towers, 20 Chapel Street, Brookline, Mass. at 3:00 P.M. Annual Meeting: May 20, 1976.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY, CHAPTER OF

ACR

Secretary-Treasurer, Dr. Edward P. Kane, Claremont Gen. Hosp., Claremont, N. H. 03743. Meets four to six

times yearly.

New Mexico Society of Radiologists, Chapter of ACR

Secretary, Dr. W. M. Jordan, 1100 Central Ave. S.E.,

Albuquerque, N. M. 87106. Four meetings annually,
three held in Albuquerque, N. M., and one held at time
and place of New Mexico State Medical Society annual meeting.

NEW ORLEANS RADIOLOGICAL SOCIETY, INC. Secretary-Treasurer, Dr. Jimmy L. Mains, P.O. Box 446, Gretna, La, 70053. Meets bimonthly at local restaurants selected by the President. Spring Conference.

New York Roentgen Society

Secretary-Treasurer, Dr. Thomas C. Beneventano, 111 East 210th St., Bronx, N. Y. 10467. Meets monthly on the 3rd Monday at the New York Academy of Medicine at 4:30 P.M. Annual Spring Conference, Waldorf-Astoria Hotel, New York, N. Y., April 22-24, 1976. A.M.A. Cat. I credit. Further information may be obtained from Dr. Albert A. Dunn, Roosevelt Hosp., New York, N. Y.

New York State Chapter of ACR
Secretary-Treasurer, Dr. Albert F. Keegan, 6 Secor Dr.,
Port Wash., N. Y. 11050.

NORTH AMERICAN SOCIETY OF CARDIAC RADIOLOGY Secretary-Treasurer, Dr. Erik Carlson, Univ. Calif., San Francisco, Calif. 94143.

North Carolina Chapter of ACR

Secretary-Treasurer, Dr. Ernest B. Spangler, Wesley I.ong Hosp., Greensboro, N. C. 27402. Meets twice a year. The Spring Meeting is held at the time of the meeting of the North Carolina Medical Society. The Pall Meeting is held in November at the Mid Pines Club, Southern Pines,

NORTH DAKOTA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. Marshall Landa, P. O. Box 6001, Fargo, N. D. 58102. Meets at time of State Medical Association meeting. Other meetings arranged on call of the President.

NORTH FLORIDA RADIOLOGICAL SOCIETY Secretary, Dr. David F. Bew, University Hospital of Jacksonville, 655 W. Eighth Street, P.O. Box 2751, Jacksonville, Fla. 32203. Meets quarterly in March, June, September and December.

NORTHEASTERN ORLAHOMA RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Theodore J. Brickner, Jr., 5919

S. Gary Place, Tulsa, Okla. 74110.

Northeastern New York Radiological Society Secretary, Dr. Donald R. Morton, Dept. of Radiology, St. Clare's Hosp., Schenectady, N. Y. 12304. Meets in Albany area on third Wednesday of October, November, March, April, and May.

NORTHERN CALIFORNIA RADIATION THERAPY ASSOCIATION Secretary-Treasurer, Dr. John D. Earle, Stanford Medical Center, Stanford, Calif. 94304. Meets quarterly.

NORTHERN CALIFORNIA RADIOLOGICAL SOCIETY Secretary, Dr. Patrick J. Grinsell, 1207 Fairchild Ct., Woodland, Calif. 95695. Meets on the fourth Monday, Sept. through May at the Mansion Inn, Sacramento, Calif.

Northwestern New York Radiological Society
Secretary, Dr. Barbara E. Chick, Glens Falls Hospital,
Glens Falls, N. Y. 12801.
Northwestern Ohio Radiological Society
Secretary, Dr. Richard W. Siders, 421 Michigan, Toledo,
Ohio 43624. Meets 3rd Wednesday from September to

Ohio State Radiological Society, Chapter of ACR Secretary, Dr. James Farmer, Cleveland, Ohio.

OKLAHOMA STATE RADIOLOGICAL SOCIETY, CHAPTER OF

Secretary, Dr. George H. Ladd, 4616 Denison, Muskogee, Okla. 74401. Meets in January, May and October.

ORANGE COUNTY RADIOLOGICAL SOCIETY

Secretary, Dr. William E. Danko, 2601 E. Chapman, Orange, Calif. 92667. Meets on fourth Tuesday of the month, excluding June, July, August, and December, at Orange County Medical Association Bldg., Orange, Calif.

OREGON STATE RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Ray F. Friedman, 3324 S. W. 44th St., Portland, Ore. 97221. Meets on second Wednesday of month, October through April, at the University Club, Portland, Ore.

ORLEANS PARISH RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph V. Schlosser, Charity Hospital,
New Orleans, La. 70113. Meets second Tuesday of each

Pacific Northwest Radiological Society
Secretary-Treasurer, Dr. Betty J. Wood, Dept. of Radiol.,
Vancouver General Hosp., Vancouver 9, B. C., Canada. Annual Meeting.

PENNSYLVANIA RADIOLOGICAL SOCIETY, CHAPTER OF ACR

Secretary, Dr. Joseph A. Marasco, Jr., St. Francis General Hosp., Pittsburgh, Pa. 19141. Philadelphia Roentgen Ray Society Secretary, Dr. Marvin E. Ha-kin, 230 N. Broad St., Philadelphia, Pa. 19102. Meets first Thursday of each month at 5 P.M., from Cctober to May in Thompson Hall, College of Physicians. PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. Klaus M. Bron, Presbyterian-Univ. Hosp., Pittsburgh 15213. Meets second Wednesday of month, September through May, at the Pittsburgh Athletic Association.

RADIATION RESEARCH SOCIETY Executive Secretary, Richard J. Burk, Jr., 4211 39th St., N.W., Washington, D. C. 20016 Annual Meeting. RADIOLOGICAL SOCIETY OF CONNECTICUT, INC., CHAPTER

Secretary, Dr. Gerald L. Baker, 85 Jefferson St., Hartford, Conn. 06106. Meets in Oct., Jan., March, and June.

RADIOLOGICAL SOCIETY OF GREATER CINCINNATI Secrétary-Treasurer, Dr. Alvin Nathan, c/o Academy of Medicine, 320 Broadway, Cincinnati, Ohio 45202. Meets first Monday of each month at Cincinnati Academy of Medicine.

RADIOLOGICAL SOCIETY OF NEW JERSEY, CHAPTER OF ACR Secretary, Dr. Fred M. Palace, 11 Dale Dr., Morristown, N.J. 07960. Monthly meetings in East Orange and Trenton, N.J. Semi-Annual Meeting in Nov.
RADIOLOGICAL SOCIETY OF RHODE ISLAND, CHAPTER OF ACR

Secretary-Treasurer, Dr. Daniel J. Alves, Rhode Island Hosp., Providence, R. I. 02902.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA Secretary-Treasurer, Dr. A. Franklin Turner, LAC-USC Medical Center, Room 3418, 1200 North State St., Los Angeles, Calif. 90033. Meets three times a year, usually October, February and May.

RADIOLOGICAL SOCIETY OF THE STATE OF NEW YORK

Secretary-Treasurer, Dr. John W. Colgan, 273 Hollywood

Ave., Rochester, N. Y. 14618.

REDWOOD EMPIRE RADIOLOGICAL SOCIETY Secretary, Dr. Charles E. Carter, 121 Sotoyome St., Santa Rosa, Calif. 95405. Meets second Monday every other month.

RICHMOND COUNTY RADIOLOGICAL SOCIETY

Secretary, Dr. Frederick S. Vines, 11830 Rothbury Dr.,
Richmond, Va. 23235. Meets third Thursday of each month at the Aberdeen Barn.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y. Secretary-Treasurer, Dr. Robert J. Bruneau, Rochester General Hosp., Rochester, N. Y. 14621. Quarterly meetings on the call of the President, at the Rochester Academy of Medicine.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. Lorenz R. Wurtzebach, 4200 E. Ninth Ave., Denver, Colo. 80220. Annual meeting: Brown Palace Hotel, Denver, Colo., Aug. 21–23, 1975. SAN ANTONIO-CIVILIAN MILITARY RADIOLOGICAL SOCIETY

Secretary, Dr. James R. Stewart, Oak Hills Medical Ctr., San Antonio, Tex. 78209. Meets third Wednesday of each month at Fort Sam Houston Officers Club at

6:30 P.M.
SAN DIEGO RADIOLOGICAL SOCIETY

President, Dr. Donald J. Fleischli, 7849 Fay Ave., La
Jolla, Calif. 92037. Meets the first Wednesday of each month Sept. through June at the University Club.

SAN FRANCISCO RADIOLOGICAL SOCIETY Secretary-Treasurer, Dr. Charles A. Gooding, Univ. of Calif. Med. Ctr., San Francisco, Calif. 94122.

Section on Radiology, California Medical Association Secretary, Dr. William H. Graham, 630 East Santa Clara St., San Jose, Calif.

Section on Radiology, Medical Society of the District of Columbia

Secretary-Treasurer, Dr. Albert M. Zelna, 21 Masters St.,
Potomac, Md. 20854. Meets at Medical Society Library,
third Wednesday of January, March, May and October

Section of Radiology, National Medical Association Secretary, Dr. Ruby Brooks, Dept. Radiol., Veterans Adm. Hosp., P.O. Box 511, Tuskogee, Ala. 36083. Annual

Section on Radiology, Southern Medical Association Secretary, Dr. Mario A. Calonje, 1514 Jefferson Highway, New Orleans, La. 70121. Annual Meeting.

Section on Radiology, Texas Medical Association Secretary, Dr. George F. Crawford, St. Elizabeth Hospi-Beaumont, Tex. Meets annually with the Texas Medical Association.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. W. R. Harwell, 608 Travis St., Shreveport, La. Meets monthly on third Wednesday at 7:30 P.M., September to May inclusive.

SOCIETY FOR PEDIATRIC RADIOLOGY Secretary-Treasurer, Dr. John P. Dorst, 601 N. Broadway, Baltimore, Md. 21205. Annual meeting: Marriott Hotel, Atlanta, Ga., Sept. 28-29, 1975. SOCIETY OF GASTRO-INTESTINAL RADIOLOGISTS

Secretary-Treasurer, Dr. John R. Amberg, University Hospital, 225 W. Dickinson St., San Diego, Calif. 92103. SOCIETY OF NUCLEAR MEDICINE

Secretary, Dr. E. James Potchen, Edward Mallinckrodt Institute of Radiology, 660 S. Euclid Ave., St. Louis, Mo. 63110. Administrative Officer, Mrs. Margaret Glos, 211 E. 43rd St., New York, N. Y. 10017. Annual Meeting.

South Bay Radiological Society

Secretary, Dr. Robert Mindalzun, Valley Radiologists,
Inc., 100 O'Connor Dr., San Jose, Calif. 95128. Meets
the 2nd Monday of each month at the Santa Clara
County Medical Society Bldg., 700 Empey Way, San
Jose, Calif.

SOUTH CAROLINA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. George W. Brunson, 1406 Gregg St Columbia, S. C. Annual meeting (primarily business) in conjunction with the South Carolina Medical Association meeting in May. Annual fall scientific meeting at

tion meeting in May. Annual fall scientific meeting at time and place designated by the president.

SOUTH COAST RADIOLOGICAL SOCIETY CHAPTER OF ACR Secretary-Treasurer, Dr. Richard T. Love, Santa Barbara Med. Clin., 215 Pesetas Lane, Santa Barbara, Calif. 93110. Meets fourth Tuesday of alternate months, Sept., Nov., Jan., March and May.

SOUTH DAKOTA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary, Dr. M. F. Petereit, 2416 S. Phillips, Sioux Falls, S. D. 57105. Meets in spring with State Medical Society and in fall.

Society and in fall.

Society and in fall.

Southern California Radiation Therapy Association Secretary-Treasurer, Dr. Duane J. Gillum, 250 W. Pueblo St., Santa Barbara, Calif. 93105. Meets quarterly.

Southern Radiological Conference
Secretary-Treasurer, Dr. J. W. Maxwell, P.O. Box 2144
Mobile Ala. 36601. Annual Meeting: Grand Hotel, Point Clear, Ala., Jan. 31-Feb. 2, 1976.

Tennessee Radiological Society, Chapter of ACR
Secretary-Treasurer, Dr. Jerry W. Grise, Methodist Hosp., 1265 Union Ave., Memphis, Tenn. 38104. Meets annually at the time and place of the Tennessee State Medical Association meeting.

Texas State Radiological Society, Chapter of ACR Secretary, Dr. Francis E. O'Neill, 1128 Nix Prof. Bdg., San Antonio, Tex. 78205.

San Antonio, Tex. 78205.

THE FLEISCHNER SOCIETY Secretary, Dr. E. Robert Heitzman, State University of New York Upstate Medical Center, Syracuse, N. Y. 13210. Annual Meeting: St. Francis Hotel, San Francisco, Calif., May 28-31, 1975.

TRI-STATE RADIOLOGICAL SOCIETY Secretary, Dr. Alfred Lessure, Welborne Hosp., Evansville, Ind. 47714. Meets bimonthly on the third Wednesday at Arco Hospitals.

Upper Peninsula Radiological Society Secretary, Dr. A. Gonty, Menominee, Mich. Meets quarterly

UTAH STATE RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Patrick D. Lester, Dept. Radiol., University of Utah Medical Center, Salt Lake City, Utah 84112. Meets quarterly at Holy Cross Hospital.

Vermont Radiological Society, Chapter of ACR Secretary, Dr. J. Lorimer Holm, R.R. #3, Barre, Vt. 05641.

VIRGINIA CHAPTER OF ACR

Secretary-Treasurer, Dr. Charles P. Winkler; 3500 Kensington Ave., Suite 2-A, Richmond, Va. 23221.

WASHINGTON, D. C., CHAPTER OF ACR.

Secretary-Treasurer, Dr. Robert M. Allen, 9312 Convento Terr., Fairfax, Va. 22030.

WASHINGTON STATE RADIOLOGICAL SOCIETY, CHAPTER OF Secretary-Treasurer, Dr. Donald J. Hesch, 3216 N.E. 45th Place, Seattle, Wash. 98105.

WEST VIRGINIA RADIOLOGICAL SOCIETY, CHAPTER OF ACR Secretary-Treasurer, Dr. Andrew W. Goodwin, II, 200 Med. Arts Bldg., Charleston, W. Va. 25301. Meets concurrently with annual meeting of West Virginia State Medical Society, other meetings arranged by program committee.

WESTCHESTER COUNTY RADIOLOGICAL SOCIETY Secretary, Dr. Leonard Cutler, 16 Guion Place, New Rochelle, N. Y. 10802. Meets on second Tuesday of October, December, February and May.

WISCONSIN RADIOLOGICAL SOCIETY, CHAPTER OF ACR

Secretary-Treasurer, Dr. June Unger, Wood VA Hosp., Wood, Wis. 53193. Meets twice a year, May and September.

WISCONSIN SOCIETY OF THERAPEUTIC RADIOLOGISTS

Secretary, Dr. Alvin Greenberg, Radiother. Ctr., Univ. Hospitals, Madison, Wis. 53706. Meets quarterly. Wyoming Radiological Society, Chapter of ACR Secretary, Dr. Ross J. Collie, Box 96, Lander, Wyo. 82520. Meets in fall with State Medical Society and in spring on call of President.

#### MEXICO, PUERTO RICO AND CENTRAL AMERICA

Asociación Costarricense de Radiología

ASOCIACIÓN COSTARRICENSE DE RADIOLOGÍA

Secretary, Dr. Rafael Umaña-Umaña, Apartado 8-5340,
San José, Costa Rica.

ASOCIACÓN DE RADIÓLOGOS DE CENTRO AMERICA Y
PANAMÁ. Comprising: Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panamá

Secretary-General, Dr. Francisco Miranbell Solis, Apartado 3352, San José, Costa Rica, Central America. Meets
annually in a rotating manner in the six countries.

annually in a rotating manner in the six countries.

Asociación Puertorriqueña de Radiología

Secretary, Dr. R. B. Díaz Bonnet, Suite 504, Professional
Bldg., Santurce, Puerto Rico.

Sociedad de Radiología de Salvador Secretary, Dr. Carlos Meijia, 5a Av. Nte. No. 434, San Salvador, Rep. El Salvador.

SOCIEDAD DE RADIOLOGÍA DE GUATEMALA Secretary, Dr. Carlos E. Escobar, 92, Calle A 0-05, Zona 1, Guatemala

Sociedad Mexicana de Radiología, A.C.
Coahuila. No. 35, México 7, D.F., México.
Secretary-General, Dr. Jorge Cano Coquí. Meets first
Monday of each month.

Sociedad Radiológica Panameña Secretary, Dr. L. Arrieta Sánchez, Apartado No. 6323, Panama, R. de P. Meets monthly in a department of radiology of a local hospital chosen at preceding meeting. SOCIEDAD RADIOLÓGICA DE PUERTO RICO

Secretary, Dr. Heriberto Pagán Sáez, Box 9387, Santurce, Puerto Rico. Meets second Thursday of each month at 8:00 P.M. at the Puerto Rico Medical Association Bldg. in San Juan.

#### British Commonwealth of Nations

Association of Radiologists of the Province of Quebec 121 Boul. Taschereau, Greenfield Park, P. Q., Canada. Meets four times a year.

BRITISH INSTITUTE OF RADIOLOGY Honorary Secretaries, D. H. Traspnell, M. Cohen, 32 Welbeck St., London, WIM/7PG, England.

CANADIAN ASSOCIATION OF PHYSICISTS, DIVISION OF MED-ICAL AND BIOLOGICAL PHYSICS Honorary Secretary-Treasurer, Dr. R. G. Baker, Ontario Cancer Foundation, Ottawa Civic Clinic, 1053 Carling Ave., Ottawa 3, Ont., Canada.

CANADIAN ASSOCIATION OF RADIOLOGISTS Honorary Secretary, Dr. Ross O. Hill, Suite 806, 1440 St. Catherine St. West, Montreal 107, Que., Canada. Thirty-eighth Annual Meeting: Toronto, Ont., May 11-16, 1975.

EDMONTON AND DISTRICT RADIOLOGICAL SOCIETY

Secretary Dr. Land May 11-16, 1975.

Secretary, Dr. L. A. Koller, Suite 360, Professional Bldg., 10830 Jasper Ave., Edmonton 15, Alberta, Canada.

Meets third Thursday of each month October to May, except December, at various Edmonton Hospitals.

FACULTY OF RADIOLOGISTS

Honorary Secretary, P. D. Thomson, 28 Portland Pl., London, W1N 4DE. MONTREAL RADIOLOGICAL STUDY CLUB

Secretary, Dr. W. Paul Butt, Montreal General Hospital, Montreal, Que., Canada. Meets first Tuesday evening, October to April.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDI-CINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 8:15 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1 M8AE, 1 England.

Société Canadienne-Française de Radiologie Secretary-General, Dr. Hubert Sasseville, Verdun Hospital, Montréal, P. Q., Canada. Meets every third Tuesday from October to April.

THE HOSPITAL PHYSICISTS' ASSOCIATION

Honorary Secretary, J. B. Massey, B.Sc., Christie Hosp, and Holt Radium Institute, Physics Department, Withington, Manchester M20 9BX, England.

TORONTO RADIOLOGICAL SOCIETY

Secretary, Dr. George Wortzman, Toronto General Hosp., Toronto 12, Ont., Canada. Meets second Monday of each month, September through May.

THE ROYAL AUSTRALASIAN COLLEGE OF RADIOLOGISTS Honorary Secretary, Dr. T. P. Loneragan, 45 Macquarie St., Sydney, N.S.W. 2000, Acstralia.

#### South America

Colégio Brasileiro de Radiologia

Secretary-General, Dr. José Marcos Pires de Oliveira, Caixa Postal 5984, São Paulo, Brazil.

FEDERACIÓN ARGENTINA DE SOCIEDADES DE RADIOLOGÍA Branches of the Federation are: Sociedad de Radiólogos de la Provincia de Córdoba; Sociedad Argentina de Radiología; Asociación Argentina de Radiología; Sociedad de Radiología, Radioterapéutica y Medicina Nuclear de Rosario; Sociedad de Radiología y Medicina Nuclear del Centro y Sudeste de la Provincia de Buenos Aires (Mar del Plata); Sociedad Salteña de Radiología y Medicina Nuclear; Sociedad de Radiología de Tucumán; Sociedad de Radiologia del Nordeste Argentino; Sociedad de Ra-diología de La Plata; and Sociedad de Radiología de San

Secretary-General-Treasurer, Dr. Roberto Habichayn, Av.

Colón 637, Córdoba, Argentina.

Congress will be organized by Sociedad de Radiología, Radioterapéutica y Medicina Nuclear de Rosario in 1975.

Sociedad Argentina de Radiología

Secretary-General, Dr. Alba de la Torre, Santa Fé 1171, Buenos Aires, Argentina. Meets first Wednesday evening, April through December.

Sociedad Boliviana de Radiología

Secretary, Dr. Javier Prada Mendez, Casilla 1182, La Paz, Bolivia. Meets monthly. General assembly once every two years.

Sociedade Brasileira de Radiologia

Secretary, Dr. Armando Rocha Amoédo, Caixa Postal 1532, Rio de Janeiro, Brazil. General Assembly meets every two years in December.

Sociedade Brasileira de Radioterapia
Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 p.m. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Chilena de Radiología
Secretary, Dr. Manuel Neira, Casilla 13426, Santiago,
Chile. Meets first Friday of each month at Av. Santa María 1810 at 7:00 P.M.

Sociedad Colombiana de Radiología

Secretary-General, Dr. Gustavo Sánchez Sánchez, Bogotá, Colombia. Meets last Thursday of each month.

Sociedad Ecuatoriana de Radiología

Secretary, Dr. Luis Blum, Casilla 3712, Guayaquil, Ecua-

SOCIEDAD PARAGUAYA DE RADIOLOGÍA

Secretary, Dr. Hugo Volpe Rios, 15 de Agosto 322, Asunción, Paraguay.

Sociedad Peruana de Radiología • Secretary-General, Dra. Ladis Delpino, Av. General Santa Cruz No. 315, Miraflores, Lima, Perú, Casilla Correo, 2306, Lima, Perú. Meets monthly except during January, February, and March.

SOCIEDAD DE RADIOLOGÍA DEL ATLANTICO

Secretary, Dr. Raul Fernandez, Calle 40 #41-110, Baran-quilla, Colombia. Society meets monthly at the Instituto de Radiología.

Sociedad de Radiología del Nordeste Argentino Secretary-General, Dr. Francisco J. Velar, Catamarca 561.

Corrientes, Argentina.
Sociedad de Radiología de La Plata

Secretary, Dr. Hiram D. Haurigot, Calle 50 No. 374, La Plata, Árgentina.

Sociedad de Radiología, Cancerología y Física Médica del Uruguay Secretary-General, Dr. Manuel Gonzáles Maseda. Av.

Agraciada 1464, piso 13, Montevideo, Uruguay. Sociedade de Radiología de Pernambuco

Secretary, Dr. Manoel Medeiros Instituto de Radiologia da Faculdade de Medicina da Universidade do Recife, Caixa Postal 505, Pernambuco, Brazil.

Sociedad de Roentgenología y Medicina Nuclear de

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Paz. 151, Córdoba, Argentina.

Sociedad de Radiología, Radioterapéutica y Medicina Nuclear de Rosario

Secretary-General, Dr. Federico Frágola, Santa Fe 1798,

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Sociedad Salteña de Radiología y Medicina Nuclear Treasurer, Dr. Julio Luis Baldi, Av. Sarmiento 536, Salta, Argentina.

Sociedad Venezolana de Radiología y Medicina Nu-

Secretary-General, Dr. Salvador Itriago Borgas, Apartado Postal 9213, Candelaria, Caracas, Venezuela. Meets monthly, third Friday at Colegio Médico del Distrito Federal, Caracas.

## CONTINENTAL EUROPE

ÖSTERREICHISCHE RÖNTGEN-GESELLSCHAFT

Secretary, Dr. Ernst Kotcher, Wiener Allgemeine Poli-klinik Mariannengasse 10, A-1090 Wien, Austria. Meets second Tuesday of each month in Allgemeine Poliklinik. Société Royale Belge de Radiologie

General Secretary, Dr. Joseph Baeyens, Alost, Belgium. Meets in February, March, May, June, September, October, November and December.

Société Européenne de Radiologie Pédiatrique Secretary, Dr. J. Corbaton, Clinica Infantil "La Paz," Av. Generalissimo, 117 Madrid 34, Spain. Annual Meet-

Ing: Madrid, Apr. 24-26, 1975.

Permanent Secretary, Clément Fauré, Hôpital des Enfants
Malades, 149, rue de Sèvres, 75 730, Paris Cadet 15, France.

Société Française de Radiologie Médicale, Médecine Nucléaire et Électrologie, and its branches: Soci-ÉTÉ DU SUD-OUEST, DU LITTORAL MÉDITERRANÉEN, DU CENTRE ET LYONNAIS, DU NORD, DE L'OUEST, DE L'EST, DU MASSIF CENTRAL, D'OUTRE-MER ET D'ÉTRANGER. Parent Society meets third Monday of each month, except during July, August and September, rue de Seine 12, Paris, France.

Secretary-General, Dr. Ch. Proux, 9 rue Daru, Paris 75008, France.

Société Française de Neuroradiologie

Secretary-General, Professeur agr. R. Djindjian 16, rue de l'Université 75, Paris 7°, France. Annual meeting.

Československá Radiologická Společnost

Secretary, Associate Professor Jaromír Kolář, M.D.,
Sc.D., Radiological Clinic, Praha 2, U nemocnice 2,
Czechoslovakia. Meets monthly except during July,
August and September. Annual general meeting.

DEUTSCHE RÖNTGENGESELLSCHAFT

President, Professor Dr. med. Walter Frommhold, Director of Medizinisches Strahleninstitut der Universität
Tübingen, Röntgenweg 11, 7400 Tübingen, Germany.
FACULTY OF RADIOLOGISTS OF THE ROYAL COLLEGE OF

FACULTY OF RADIOLOGISTS OF THE ROYAL COLLEGE OF SURGEONS IN IRELAND

Honor. Secretary, Max. J. Ryan, St. Stephen's Green, Dublin 2. Annual Meeting, Oct. 25 and 26, 1974. Società Italiana di Radiologia Medica e Medicina

Nucleare
Administrative Secretary, Prof. E. Conte, Ospedale
Mauriziano, 10128 Torino, Italy. Meets annually.

Societas Radiologica Danica Secretary, Dr. Bent Langenfeldt, Tretommervej 20a, DK. 8240 Risskov, Denmark.

NEDERLANDSE VERENIGING VOOR RADIOLOGIE

Secretary, Dr. J. D. Mulder, Dept. of Rad., Akademisch
Ziekenhuis, Leiden, Netherlands.

Norsk Forening for Medicinsk Radiologi General Secretary, Gunnar Stake, Rikshospitalet, Oslo, Norway.

Scandinavian Radiological Society
Secretary-General, Professor C. F. Unnerus, M.D., Hagalung-Tapiola, Havsvindsvägn 5 C., Finland. Annual
Meeting.

Sociedad Española de Radiología y Electrología Médicas y de Medicina Nuclear Secretary-General, Dr. Pilar Gallar Barberá, Villanueva, 11, Madrid I, España. Meets every other Saturday evening of each month, Oct. to June, inclusive, in Madrid.

SOCIEDADE PORTUGUESA DE RADIOLOGIA E MEDICINA NUCLEAR

Secretary-General, Dr. Luís Aires de Sousa, Av. Elias Garcia, 123- 1, Esg.-Lisboa i-Portugal. Svensk Förening för Medicinsk Radiologi

Secretary, Dr. Hanz Ringertz, Röntgendiagnostika Avdelningen, Karolinska Sjukhuset 104 01 Stockholm 60, Sweden.

Schweizerische Vereinigung für Radiologie, Nuklearmedizin und Strahlenbiologie (Association Suisse de Radiologie, Médecine Nucléaire et de Radiobiologie)
Secretary, Dr. med. Gustav Schoch, Bethesdaspital, Gellerstrasse 144, 4000 Basel, Switzerland.

#### ASTA

Bengal Radiological Association

Honorary Secretary, Dr. B. Chatterji, 262 Rash Behari
Ave., Calcutta 700019, India. Meets 1st Fri. and 3rd
Wed. of every month.

Indian Radiological Association

Honor. Gen. Secretary, Dr. S. P. Aggarwa!, 10-B Kasturba
Ghandi Marg, New Delhi iiocoi. 28th Indian Congress of
Radiology will be held in Hyderabad in 1975.

Indonesian Radiological Society

Secretary, Dr. Gani Iljas Sasmitaatmadja, Radiology Dep., Faculty of Medicine, University of Indonesia, Salemba 6, Jakarta; Indonesia.

IRANIAN RADIOLOGICAL SOCIETY

Secretary, Dr. Majid Rooholamini, P.O. Box No. 14-1151, Teheran, Iran. The Society meets on the second Saturday of each month. 5th Iranian Congress of Radiology, Apr. 12-17, 1975.

ISRAEL RADIOLOGICAL SOCIETY

Secretary, Dr. M. A. Lerner, Hesharon Hosp., Petah-Tigva, Israel.

PHILIPPINE COLLEGE OF RADIOLOGY
Secretary-Treasurer, Dr. Eduardo V. Nievera, Box 1284
Commercial Center, Makati, Rizal D-708, Philippines.
Meets every second Thursday of the month.

RADIOLOGICAL SOCIETY OF THAILAND

Secretary, Prof. Rojana Suvansuthi, M.D., Ph.D.,
Depart. of Rad., Sirizaj Hospital, Faculty of Medicine,
Mahidol University, Bangkok 7, Thailand.

#### AFRICA

Association of Radiologists of West Africa

Honorary Secretary, C. A. Beetlestone, M.B., B.S.,
D.M.R.D., Dept. Radiol., University College Hosp.,
Ibadan, Nigeria.

RADIOLOGICAL SOCIETY OF SOUTH AFRICA
Secretary, Dr. A. Visser, P. O. Box 8850, Johannesburg,
South Africa.

South African International Radiological Congress Director, Dr. Paul Sneider, P.O. Box 4878, Johannesburg, South Africa.



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#### ROENTGEN DIAGNOSIS

#### HEAD

ALKER, GEORGE J., JR., OH, YOUNG S., LESLIE, EUGENE V., LEHOTAY, JUDITH, PANARO, VICTOR A., and ESCHNER, EDWARD G. Postmortem radiology of head and neck injuries in fatal traffic accidents. *Radiology*, March, 1975, 114, 611-617. (Address: George J. Alker, M.D., Department of Radiology, Edward J. Meyer Memorial Hospital, 462 Grider Street, Buffalo, N. Y. 14215.)

There have been several studies documenting the fatal injuries sustained in auto accidents based upon autopsy examination of the victims. This is the first known report of roentgenographic examination of victims of fatal automobile accidents.

Postmortem examinations were performed on 146 consecutive persons who either died in or shortly after an auto accident. The routine examination consisted of 3 views of the skull and 2 views of the cervical spine. Examination of other parts of the body was performed as seemed indicated on the basis of visible injuries.

Cranio-cervical injuries were found in 82 of the 146 subjects. The remaining 64 died usually as a result of chest or abdominal injuries. Skull fractures were found in 51 victims and another 10 had both skull and cervical spine fractures. The skull fractures varied from simple linear fractures to severe devastating injuries. Of the total of 61 persons with skull fractures, intracranial air was identified in 41, indicating the severity of the injuries. In 23, the air collection was extracerebral. In 18, it was subdural or subarachnoid. A number had air in the ventricular system or spinal canal. Air fluid levels in the paranasal sinuses, particularly the sphenoid, were common. Air was also identified in the jugular veins or right heart in some victims.

Of the cervical spine injuries, 17 were flexion type injuries and 7 were extension type injuries. In the remainder, the mechanism of injury could not be determined. Atlantoaxial dislocations were found in 8 persons. C2 injuries, usually a "hangman's" fracture of the pedicles with subluxation or dislocation of C2-C3, were found in 10. Marked soft tissue swelling in the retropharyngeal area accompanied the cervical spine fractures. Often, soft tissue emphysema was also seen.

Cervical spine injuries were found more frequently in this study than in previous series based upon autopsy alone, probably because of the difficulty in detecting such injuries by autopsy.—J. M. Stoebner, M.D.

Moore, James S., Jr., Kieffer, Stephen A., Goldberg, Marvin E., and Loken, Merle K. Intracranial tumors: correlation of angiography with dynamic radionuclide studies. Radiology, May, 1975, 115, 393-398. (Address: James S. Moore, Jr., M.D., 645 Montcalm Place, St. Paul, Minn. 55116.)

A group of 100 supratentorial brain tumors—all of which were subsequently pathologically proved—was studied with dynamic and static brain scans and angiographically. The characteristics of the angiographic appearance of various brain neoplasms were compared with the presence or absence of an abnormal radionuclide flow pattern utilizing bolus injection of 20 mCi <sup>99m</sup>Tc sodium pertechnetate.

Of the 100 tumors, 23 showed an abnormal focus of radioactivity during the dynamic portion of the brain scan and 88 were visualized on the static views. All tumors which were demonstrated on the dynamic study were subsequently visualized on the static images. Positive dynamic studies were most frequent in meningioma, followed by glioblastoma, low grade glioma and metastatic tumors in descending order. Nineteen of the 23 positive dynamic studies (82 per cent) were associated with increased size of vessels supplying the tumor as demonstrated angiographically, while only 7 of 77 tumors with a normal dynamic study (9 per cent) had enlarged vessels. Thus, those tumors with large supplying vessels, regardless of histology, demonstrated increased activity on the dynamic portion of the scan. However, the presence of tumor vascularity does not guarantee that the tumor will be demonstrated during the dynamic portion of the scan, as only 41 per cent of those tumors with some degree of tumor stain or vascularity were demonstrated on the dynamic study.

The dynamic brain scan did not show increased activity in those tumors graded avascular at angiography: on the other hand, none of those avascular tumors showed decreased activity.

Increased activity on the dynamic portion of the brain scan correlated strongly with 2 angiographic findings: increased size of supplying vessels; and a combination of external and internal carotid arterial supply.—W. I. Dittman, M.D.

#### Neck and Chest

OSTENDORF, PETER, BIRZLE, HERRMANN, VOGEL, WOLFGANG, and MITTERMAYER, CHRISTIAN. Pulmonary radiographic abnormalities in shock: roentgen-clinical-pathological correlation. *Radiology*, May, 1975, 115, 257-263. (Address: Dr. Peter Ostendorf, Medizinische Universitätsklinik, Abteilung II, Otfried-Müller-Strasse, 74 Tübingen, W. Germany.)

Shock following trauma, sepsis, and postoperative states produces an alteration or disturbance in the pulmonary microcirculation. This alteration causes respiratory insufficiency which overshadows the primary cause of the shock episode. This pulmonary insufficiency then becomes the most common cause

of death. In fact, Bredenberg et al. found that the lungs were related to the cause of death in 70 per cent of the cases investigated in their series.

The authors describe in detail the clinical picture, roentgenographic findings, and the pathologic-anatomic details of 46 patients involved in the shock syndrome.

Five roentgenographic stages are outlined:

 No roentgenographic changes in spite of decreased pO<sub>2</sub> and pCO<sub>2</sub>.

2. The first identifiable roentgenographic findings are fuzzy indistinct vessels. The pathologic findings at this time show actual edema involving the vessel wall as well as edema in the perivascular and interstitial tissue. It is noted that these changes occurred only after the capillary pressure increased above 18-25 mm. mercury.

3. Early formation of intra-alveolar edema is seen as localized ill-defined "acinar" nodules. This finding progresses to the more typical alveolar

edema.

4. A reticular net-like pattern was observed in 8 cases. This finding was irreversible. The finding did not occur early but appeared in the immediate pre-final stage.

5. The pre-final stage is characterized by overlapping of nonspecific findings. The picture is pre-terminal and irreversible. Very likely, the findings are secondary in part to bronchopneumonia.

The point made by the article is that a reliable diagnostic indicator of shock-determined lung changes is the transition from the perivascular edema to a stage of patchy acinar focal densities and, following this, a diffuse bilateral haziness or cloudiness which then progresses to total opacity.—J. P. Eberts, M.D.

FELDMAN, FRIEDA, ELLIS, KENT, and GREEN, WILLIAM M. The fat embolism syndrome. Radiology, March, 1975, 114, 535-542. (Address: Frieda Feldman, M.D., 622 W. 168th Street, New York, N. Y. 10032.)

It is important for the radiologist to recognize the fat embolism syndrome as a serious complication of skeletal injury, because early recognition and appropriate respiratory care may save a life. The fat embolism syndrome can be broadly viewed as one pathway leading toward acute respiratory failure or the "acute respiratory distress syndrome."

The diagnosis of fat embolism syndrome is made on the basis of the clinical picture of pulmonary and cerebral dysfunction in a patient who is usually young and who, most commonly, 24 to 48 hours after long-bone fracture, manifests fever, abnormal arterial blood gases and at least one other manifestation such as an abnormality on a chest roentgenogram, petechiae, fat in the retinal vessels on funduscopy, fat on cryostat frozen section of clotted blood,

or fat in the urine. The major pulmonary manifestations are dyspnea, tachypnea, hyperpnea and cyanosis. With changes in mental status the patient may become confused, restless, and rambunctious or drowsy, stuporous or comatose. Nonfocal seizures may occur. The most severe cases become clinically indistinguishable from the "shock lung."

Characteristically, the chest film remains normal for up to 72 hours. Widespread lung density develops beginning in the perihilar and basilar regions, but subsequently it tends to become generalized. The diffuse lung density is a combination of interstitial and alveolar patterns. In some patients the densities have a more patchy appearance which may be related to uneven involvement due to pre-existing variations in lung architecture. Pleural effusions are not part of the fat embolism syndrome. Heart and pulmonary vasculature, when visible, appear normal. After a day or two the lung density tends to become greatest at the periphery. In most cases, the pulmonary densities clear after several days to a week or more.

The pathologic basis for the acute development of diffuse lung density is a combination of pulmonary edema and hemorrhage plus diffuse microatelectasis apparently secondary to the loss of pulmonary surfactant.

Correction of significant arterial hypoxemia is the most important aspect of therapy for the fat emboli syndrome. The whole gamut of respiratory care may be required, ranging from supplemental nasal oxygen to intubation and mechanical positive pressure ventilation. In more severe cases treatment with relatively high dose corticosteroids is now widely recommended. Heparin, intravenous ethyl alcohol and low molecular-weight dextran are used but their role is controversial.—Jon F. Bergstrom, M.D.

Doppman, John L., Mallette, Lawrence E., Mark, Stephen J., Monchik, Jack M., Broadus, Arthur, Spiegel, Allen M., Beazley, Robert, and Aurbach, Gerald D. The localization of abnormal mediastinal parathyroid glands. *Radiology*, April, 1975, 115, 31-36. (Address: John L. Doppman, M.D., Department of Radiology, Building 10, Room 6S211, National Institutes of Health, Bethesda, Md. 20014.)

In the preoperative localization of parathyroid adenomas, it is of major importance to predict or exclude the presence of hyperfunctioning mediastinal glands.

Elevated concentrations of parathyroid hormone (PTH) in selectively sampled inferior thyroid veins can lateralize a source of excess PTH production but cannot assure a cervical as opposed to a mediastinal location. In the authors' experience, most mediastinal glands drain cranially into the inferior thyroid vein, especially when their arterial supply is inferior thy-

roidal. For this reason, standard sampling of cervical thyroid veins alone cannot exclude a mediastinal adenoma. Because of anastomosis between inferior thyroid and thymic veins, routine thymic vein samples will not settle the issue. Adenomas in the neck or mediastinum may cause elevated concentrations of parathyroid hormone in thymic veins. There, venous sampling alone cannot distinguish cervical from mediastinal adenomas.

Arteriography can localize mediastinal parathyroids and should be performed before any repeat exploration. Although angiographic localization studies are not recommended before the initial cervical exploration, patients with previous unsuccessful neck surgery should undergo selective arteriography followed by venous sampling, since this combined approach is most likely to locate the missing adenoma, whether in the neck or the mediastinum.

When postoperative arteriography fails to visualize the adenoma and the venous samples reveal high concentrations of PTH in the inferior thyroid veins, the missing gland is still far more likely to be found in the neck. In the authors' series of over 100 hyperparathyroid patients, a third of whom were referred after unsuccessful neck surgery, only 4 sternotomies have been performed.—J. L. Montgomery, M.D.

Schiavetti, Elisabetta, and Bombarda, Achille. Neoplasie polmonari maligne dell'infanzia. (Malignant pulmonary neoplasms of infancy.) *Radiol. med.*, Oct., 1974, 60, 817–826. (Address: Dr. Elisabetta Schiavetti, Ospedale dei Bambini, 32 via Castelvetro, 1-20154 Milano, Italy.)

A review of the literature shows that primary malignant neoplasms of the lungs rarely affect children.

The authors report in detail 5 cases which came to their observation. The ages varied between 2 years and 2 months, and 2 years and 11 months. Three patients were males and 2 were females. Histologically the neoplasms proved to be an angiosarcoma, an embryonal tumor with sarcomatous degeneration and in 2 cases, a lymphosarcoma and a dysembryonal tumor. All cases came to autopsy except for the female patient with the dysembryonal tumor who is alive and in satisfactory condition 1 year after pericardiopneumonectomy, followed by radiation therapy and chemotherapy. In all cases the left side was involved by the neoplasm.

The roentgenographic findings vary from opacification of one lung, simulating empyema or a pneumonic consolidation with associated pleural effusion, to the presence of a large pulmonary mass displacing the mediastinum toward the opposite uninvolved side. The tumor mass might present a few "humps" along its outer contour, at times hidden by the associated pleural effusion. The tomographic study of the involved lung will show clearly the marked distortion

of the bronchi and, not infrequently, amputation of primary and/or secondary bronchi.

In the differential diagnosis one should consider a carcinoma, although the differentiation is practically impossible between a secondary neoplastic lesion, a benign tumor and possibly a large abscess formation.

—A. F. Govoni, M.D.

Scheibel, Robert L., Moore, Richard, Korbuly, Dominic, Ovitt, Theron W., Payne, J. Thomas, Tuna, Naip, and Amplatz, Kurt. Regional myocardial blood flow measurements in the evaluation of patients with coronary artery disease. *Radiology*, May, 1975, 115, 379–386. (Address: Robert L. Scheibel, M.D., 121 Sotoyome Street, Santa Rosa, Calif. 95405.)

Coronary arteriography and cine left ventriculography provide information essential for selecting candidates for coronary bypass surgery. The coronary arteriograms and cine angiograms define the anatomy of the coronary arterial tree and depict the contractility of the left ventricle. These methods do not evaluate changes in regional myocardial blood flow which may be the most significant factor in causing angina pectoris.

Myocardial imaging with xenon 133 and a gamma camera was employed to evaluate total and regional myocardial blood flow. A technique, giving reproducible measurements, is described by the authors who performed radioxenon washout studies during coronary angiography.

The injection of contrast medium significantly increased myocardial tissue flow for 5 minutes. Intracoronary injection of papaverine dramatically increased the myocardial tissue flow, and the xenon washout technique readily detected the flow increase.

Correlation of the total myocardial tissue flow with the degree of coronary artery stenosis showed a definite trend toward decreased flow rates with increasing coronary artery narrowing. There is enough overlap so that these values alone cannot be used to classify patients into diagnostic categories. The technique described in this paper cannot be reliably used in deciding whether a coronary artery stenosis is hemodynamically significant.

The roentgenographic scintigrams proved valuable in the differentiation between akinesia of the left ventricle due to ischemia or that due to scarring. In spite of the presence of an occluded bypass artery, a filling defect on the scintigrams strongly suggests extensive scarring, and bypass surgery to such an artery is not indicated.—Jon F. Bergstrom, M.D.

Weiss, Michael A., Koenigsberg, Mordecai, and Freeman, Leonard M. Pulmonary arteriovenous malformation: scintigraphic demonstration and analysis. J. Nuclear

Med., March, 1975, 16, 180-182. (Address: Leonard M. Freeman, M.D., Department of Radiology, Albert Einstein College of Medicine, 1300 Morris Park Avenue, Bronx, N. Y. 10461.)

A suspected arteriovenous malformation in an 8 year old child was studied using radionuclide angiography. The chest roentgenograms showed a posteromedial density in the left lung which was suggestive of a pulmonary arteriovenous malformation. Radionuclide angiography was done using a 0.5 ml. bolus containing 6 mCi of 99mTc pertechnetate. Serial scintiphotos were obtained at 2-3 second intervals employing a gamma camera. Data were also recorded on digital magnetic tape (Intertechnique Data Processing System) at the rate of 2 frames per second.

The scintiphotos showed a band of increased activity extending directly from the pulmonary artery to the abnormal area noted in the chest roentgenograms. Information obtained from the data processor showed an intense activity in the lesion immediately after right heart filling but prior to significant pulmonary perfusion. There was a rapid "washin" and "washout," a marked decrease in perfusion of the left lower lobe, and an asymmetric perfusion of the upper lobes indicating a significant diversion of the flow in the left pulmonary artery to the arteriovenous malformation.

Pulmonary angiography showed a large arteriovenous malformation in the apical segment of the left lower lobe and a number of smaller lesions. The major lesion was resected in view of the patient's symptoms and polycythemia.

Radionuclide angiography was found to be a helpful adjunct in studying suspected pulmonary arteriovenous malformations.—*Charles W. Cooley, M.D.* 

BARD, R., and HASSANI, N. Crescent sign in pulmonary hematoma. *Respiration*, 1975, 32, 247-251. (Address: R. Bard, M.D., Department of Radiology, New York Medical College, New York, N. Y. 10029.)

Pathologic changes in patients who encounter lung trauma run the gamut from mild local pulmonary edema to alveolar capillary rupture and peribronchial hemorrhage. This is true whether the trauma is penetrating or non-penetrating and the basic defect is a loss of vessel integrity. Roentgenographic signs of damage may be evident within hours and clear over several days to several weeks. Hematoma formation is usually partially masked by surrounding contusion and can resolve over a period as long as 13 months.

A case is presented in which a well circumscribed lesion with an eccentric air crescent sign is evident in a coin lesion in the lung 2 weeks following trauma. It is pointed out that although this generally occurs in echinococcus cyst formation or other cavitary

lesions after shrinkage, trauma can be responsible.—
Robert P. Andrews, M.D.

Fulton, Robert L., and Jones, Calvin E. The cause of post-traumatic pulmonary insufficiency in man. Surg., Gynec. & Obst., Feb., 1975, 140, 179–186. (From: The Department of Surgery, University of Louisville School of Medicine, and the Price Institute of Surgical Research, Louisville, Ky.)

Approximately 10 per cent of a series of patients who were admitted to the Louisville General Hospital in a 5 month period developed post-traumatic pulmonary insufficiency. Ten to 15 per cent of these patients had primary chest or abdominal injury or multiple injuries without chest involvement. Forty per cent of these patients had either multiple injuries with chest involvement or had primary neurologic trauma. All of the patients were required to have more than 120 hours of ventilator assist before they could be included in the category of posttraumatic pulmonary insufficiency. Etiologic factors included massive fluid therapy, shock, sepsis, hypovolemic shock and replacement fluid therapy. Eighty-three per cent of the patients had sepsis appear before or with the onset of pulmonary failure. In those patients who developed sepsis, primary focus was extrapulmonary in 55 per cent. The data revealed that the usual sequence of events which took place included: (1) oligemic shock, multiple system injury, chest injury, massive fluid therapy and then sepsis, associated with sufficient pulmonary dysfunction to require frequent respiratory support; (2) in the presence of shock, treatment with large fluid loads are rarely associated with life-threatening pulmonary failure in the absence of sepsis; and (3) sepsis is the clinical state most regularly associated with development of post-traumatic insufficiency.

There is considerable discussion in regards to the necessity for transient respiratory assist in relationship to shock, sepsis, thoracic injury and the previous presence of lung injury to subsequent infection. A second factor which must be considered is the intubation required for mechanical support when plugged bronchi occur, as there is a lower resistance of the wet lung to infection. Remote infection is also discussed as well as the effects on blood of toxic products and a lowered immune response initiated by hemorrhage. The authors summarize that respiratory insufficiency most frequently follows sepsis, and when this occurs pulmonary failure may be present. This can be predisposed by fluid therapy, shock and ventilatory assistance. The most important adverse effect is pneumonia.-Robert P. Andrews, M.D.

HEEGER, H. Die Bedeutung der Myokardszintigraphie für die Diagnostik der koronaren

Herzkrankheit. (Significance of myocardial scintigraphy in the diagnosis of coronary heart disease.) Wien. klin. Wchnschr., Oct., 1974, 86, 539-543. (Address: Hanusch-Krankenhaus, Herzstation, Heinrich Collin-Strasse 30, A-1140 Wien, Austria.)

Difficulties in the diagnosis of coronary heart disease associated with angina pectoris arise from the fact that results with available tests frequently remain inconclusive. On the other hand, an early diagnosis becomes important from the standpoint of cardiac surgery. In addition to electrocardiograms, coronary arteriograms and levoventriculograms; myocardial scintigrams have proved informative. This modality is now correlated with routine electrocardiograms.

In 65 patients, scintigrams were obtained immediately following coronary arteriograms. Radioiodine in doses of 200 to 300 µCi was injected into the left coronary artery after the thyroid function had been blocked with Lugol's solution. The macroalbumin particles, with a diameter of 5 to 50 microns, were sufficiently large to embolize the terminal coronary branches, whereby their distribution in the myocardium was directly related to the perfusion.

A complete fixation defect was noted in myocardial infarcts. On the other hand, in angina pectoris without infarcts, there was a decreased particle fixation suggesting diminished myocardial perfusion and disturbed microcirculation as seen in postischemic scars. Preceding normal electrocardiograms in some of these cases had frequently resulted in a false sense of security.

Scintigrams showed complete fixation defects 27 times and decreased particle fixation 38 times. Thirteen patients had electrocardiographic changes suggesting healed transmural anterior wall defects; 8 patients merely presented ST-T changes, while 6 patients had normal electrocardiograms at rest (22 per cent).

Fifteen patients (39 per cent) with decreased particle fixation had normal electrocardiographic findings at rest, while 23 patients presented ST-T changes suggesting coronary insufficiency. Thus, normal electrocardiograms occurred almost twice as often in decreased particle fixation as in complete fixation defects.—Ernest Kraft, M.D.

#### ABDOMEN

SIMON, NORMAN M., NYMAN, KENNETH E., DIVERTIE, MATTHEW B., ROVELSTAD, RANDOLPH A., and KING, JOHN E. Pneumatosis cystoides intestinalis: treatment with oxygen via close-fitting mask. J.A.M.A., March, 1975, 231, 1354–1356. (Address: Norman M. Simon, M.D., Mayo Clinic, 200 First Street, S. W., Rochester, Minn. 55901.)

Pneumatosis cystoides intestinalis is a poorly understood disease characterized by the presence of gas-filled cysts in the small intestine or colon. Although sometimes associated with gastrointestinal tract obstruction, pulmonary disease, or collagen disease, many cases are not found to have discernible predisposing factors. Many of the patients with these cysts are asymptomatic; however, in others, diarrhea, flatulence, rectal bleeding, and pneumoperitoneum can develop.

It has been previously suggested that increasing blood oxygenation would decrease the partial pressures of other gases in the blood and thereby promote resorption of these gases from the cysts.

The authors of this article describe 4 patients with symptomatic pneumatosis cystoides intestinalis who after several days of 70 per cent oxygen delivered via a close-fitting mask, responded by showing regression of clinical symptomatology and roentgenographic findings. They express awareness of the risk of pulmonary damage from oxygen exposure and recommend that vital capacity be measured during therapy and that oxygen therapy be withdrawn if pulmonary function becomes impaired.

This method of treatment is recommended only for those patients whose pneumatosis cystoides intestinalis is symptomatic. The authors state that long-term effectiveness of this therapy is as yet unknown.—R. H. Troupin, M.D.

Goldstein, Harvey M., and Miller, Mark. Angiographic evaluation of carcinoid tumors of the small intestine: the value of epinephrine. Radiology, April, 1975, 115, 23-28. (Address: Harvey M. Goldstein, M.D., Department of Diagnostic Radiology, M. D. Anderson Hospital and Tumor Institute, University of Texas System Cancer Center, Houston, Texas 77025.)

Five patients with carcinoid of the ileum are reviewed. Epinephrine was used in 2 cases. The angiographic features of carcinoid tumor included: irregularity, kinking, and encasement of the distal intramesenteric arteries; and nonvisualization of draining veins. There was no significant hypervascularity or neovascularity, and tumor staining was minimal when epinephrine was not used.

Case reports of 2 patients are presented. In these 2 patients small doses of epinephrine markedly enhanced the tumor stain. The extent of the primary and the hepatic metastases was not visible without epinephrine. Possible mechanisms of epinephrine enhancement are discussed.—A. K. Teaford, M.D.

Galluzzi, Sergio. Il polipo pescatore: Fitobezoario pendulo da sutura dopo gastroresezione. (The fishing polyp: phytobezoar from hanging suture after gastric resection.) Radiol. med., June, 1974, 60, 507-512. (Address: Istituto di Radiologia dell'Università, 2 piazza del Duomo, I-53100 Siena, Italy.)

The surgical procedure of gastric resection calls usually for a continuous suture in the gastrojejunal anastomosis. At times this suture is not absorbed, probably because of a particular tissue reaction, and it will act as a foreign body in the gastric lumen.

It could happen that fibrin, vegetable filaments and various debris might deposit in or collect around the suture and this, at a certain time, might migrate into the efferent loop. Here, this hanging suture will keep on collecting debris, increasing in size and length as it unfolds until, completely free from its original location, it will be eliminated.

This pendulous phytobezoar can be, at times, demonstrated roentgenologically in the efferent loop as a clearly defined oval or elongated lucent shadow surrounded by the barium. In one of the illustrations accompanying the article, one can also note the anchoring segment of the suture reaching upward to the gastrojejunal anastomosis. From this image, recalling a fish caught on a line, comes the term of "fishing polyp" used by the author.

Apparently the only other report of a similar finding published in the medical literature is by Galansky (1972). The patient observed by this author came to surgery because the hanging phytobezoar was thought to be a neoplasm of the small bowel.

The reproductions of the roentgenograms are very demonstrative.—A. F. Govoni, M.D.

Schulz, H.-G., and Gottschild, D. Erfahrungen mit Metoclopramid in der röntgenologischen Funktiondiagnostik von Magen und Darm. (Experiences with metoclopramide in the roentgenologic investigation of the stomach and small bowel.) Deutsche Ztschr. Verdauungskr., 1973, 33, 299-307. (Address, Dr. H.-G. Schulz, Radiologische Klinik der Karl-Marx Universität, DDR-701 Leipzig, Liebigstrasse 20a, Germany.)

Metoclopramide, a synthetic derivative of procainamide, increases tonus and motility of the stomach with opening of the pylorus and dilatation of the duodenum. It also increases the intestinal peristalsis with accelerated passage of barium through the small bowel.

The authors performed barium meal examinations of the upper alimentary tract with Metoclopramide on 1,500 patients. Metoclopramide was given intravenously about § minutes prior to the ingestion of barium. In general, the examination with Metoclopramide was performed as a second examination to solve unclear findings of the routine barium meal examination.

The most common indication was delayed emptying of the stomach and upper duodenum with un-

satisfactory delineation of the pyloric region. In these cases the enhanced peristalsis and improved filling of the lumen after the administration of Metoclopramide allow accurate evaluation of the distal stomach. It permits distinction between true morphologic abnormalities and functional disorders as well as differentiation between benign and malignant gastric outlet stenosis. This method is also useful in the differential diagnosis of localized rigidity of the gastric wall; scars usually transmit peristaltic waves after the injection of Metoclopramide while carcinomatous infiltration exhibits persistence of mural rigidity. The dilatation of the duodenum with Metoclopramide facilitates the diagnosis of ulcers, scars, tumors, and diverticles. Although the effect of Metoclopramide on the duodenum is insufficient for hypotonic duodenography, it enriches the diagnostic possibilities without significant additional efforts. The preferred indication for pharmacoroentgenography with Metoclopramide was the diagnosis of small bowel diseases. The ileocecal region is usually visualized at 30 minutes; fragmentation of the barium column in the small bowel is absent and the mucosal pattern is extremely well delineated. Metoclopramide also expedites the passage of barium through intestinal anastomoses; this has been found extremely useful in the delineation of anastomatic stenoses, jejunal ulcers, and gastric stump carcinomas. Metoclopramide does not affect the passage of barium through the colon, nor has it any effect on the esophagus. Side-effects to Metoclopramide are rare, the authors experienced a transient dyskinetic syndrome only once.—Peter F. Winter, M.D.

FREEMAN, JOEL B., COHEN, WILLIAM N., and DENBESTEN, LAWRENCE. Cholecystokinin cholangiography and analysis of duodenal bile in the investigation of pain in the right upper quadrant of the abdomen without gallstones. Surg., Gynec. & Obst., March, 1975, 140, 371-376. (From: The Departments of Surgery and Radiology, University of Iowa Hospitals and Clinics, and Veterans Administration Hospital, Iowa City, Iowa.)

Although it is well known that a normal cholecystogram is 95 per cent accurate in excluding cholecystitis and cholelithiasis, there are a small number of problem cases in which there is strong suspicion of biliary colic in spite of the negative gallbladder study. If cholecystectomy is finally performed out of desperation in these cases, fully 35 per cent may not be relieved of their symptoms and will be labeled with the diagnosis of postcholecystectomy syndrome.

The authors have done a superb job of investigating this problem utilizing 31 patients, mostly females of varying ages, who had been thoroughly studied for symptoms consistent with intermittent or recurrent biliary colic and who had had at least 2

normal oral cholecstograms within the preceding 6 months.

Each patient was given a standard Telepaque cholecystogram without fat stimulation. A duodenal drainage tube was positioned fluoroscopically distal to the ampulla of Vater and a control anteroposterior film of the gallbladder taken. Ten cc. of normal saline were injected intravenously and followed by a slow injection of 75 Ivy units of cholecystokinin. If the patient experienced symptoms similar to clinical attacks, the test was considered positive. Serial films were taken for 30 minutes to detect gallbladder contraction, and initial fluoroscopic observations sought evidence of abnormal contractions, spasm in the neck, or proximal dilatation. The time and amount of B bile collected in the duodenal drainage tube was noted.

By combining the cholecystokinin cholangiography and duodenal drainage, it was felt that the incidence of overlooked gallbladder disease should be virtually eliminated. Normally, gallbladder contraction begins 45 seconds after cholecystokinin injection and B bile should appear within 2 minutes in the tube. The gallbladder should be 50 per cent contracted within 30 minutes, and one should obtain 30 to 50 cc. of B bile. If even after the instillation of 50 per cent magnesium sulfate into the tube one fails to obtain adequate quantities of B bile, then one can be sure that it was the gallbladder contractility and not the cholecystokinin which was defective.

In this series 22 patients were operated on with no failures and 20 cures. It is suggested that pain associated with cholecystokinin injection indicates an underlying neuromuscular disorder. Their pain results from overdistention of the gallbladder when it is filled to capacity, and spasm prevents emptying. Other patients with abnormal bile obtained through duodenal drainage had diseased gallbladders, even though the cholecystogram was normal. The technique was safe and effective and should be considered before more complicated procedures such as arteriography and laparotomy.—Arch H. Hall, M.D.

Furnémont, E. Accidents perforatifs en cours de lavement baryté: à propos d'une observation. (Bowel perforation during barium enema; case report.) Acta gastro-enterol. belg., July-Aug., 1974, 37, 373-380. (Address: Avenue de Floréal, 36 B-1180 Bruxelles, Belgium.)

Relatively rarely reported, bowel perforation during barium enema examination can have grave consequences. Such an event occurred in a 59 year old woman several years after a total hysterectomy. Upon referral to the author, the patient clearly had peritoneal barium on roentgenography. She underwent abdominal incision, aspiration of peritoneal contents, and saline lavage. The perforation was of the proximal anterior rectum at the level of a vaginal

adhesion; it was then sutured. The patient did well, but barium could still be seen in the rectal wall on roentgen filming 2 weeks later.

Perforation may be related to the mode of barium introduction, the hydrostatic pressure employed, or a pathological state of the colon. Fragility of the rectal wall can be induced by recent endoscopic maneuvers or biopsy.

The problem arises not so much from the barium, but from the sepsis accompanying the perforation. About 50 per cent mortality has been reported in the literature. Prognosis is improved by the rapidity of initiating intervention.—Alan E. Oestreich, M.D.

MÉROLA, LORENZO. Ileo biliar: patología, radiologia y clinica. (Biliary ileus: pathology, radiology and clinical features.) *Prensa méd. argent.*, July, 1974, 61, 608-614. (Address: Montevideo, Uruguay.)

A large gallstone that enters the intestine through a cholecysto-duodenal fistula can produce intestinal obstruction ("ileus"). The fistula can develop during an acute inflammatory process (although the actual passage of the stone into the intestine can occur at a later date), or be due to pressure erosion without a significant inflammatory episode.

When there is a cholecysto-duodenal fistula, the presence, or absence of persistent air in the biliary ducts would depend (assuming a competent sphincter of Oddi) on the pressure differences between the intestine and the biliary tree, and mainly on whether the cystic duct is patent or not. This roentgenographic sign would be present when the cystic duct is patent i("true internal biliary fistula"). In this situation reflux cholangitis can occur, particularly in cases of cholecysto-colonic fistula, and this would aggravate the clinical picture. If the gallstone producing the intestinal obstruction is radiopaque, it could be visualized in the plain abdominal films.

A patient being operated for acute intestinal obstruction due to a gallstone should not undergo biliary surgery at the same time.—Julian B. Alvarez, M.D.

BISLA, RANJIT, and LOUIS, HERBERT J. Acute vascular compression of the duodenum following cast application. Surg., Gynec. & Obst., April, 1975, 140, 563-566. (From: The Phoenix Orthopaedic Residency Programme, Phoenix, Ariz.)

Compression obstruction of the transverse or ascending portion of the duodenum by the superior mesenteric vessels after the application of a body cast has been given the name "cast syndrome." While rare, this condition, if not diagnosed early and treated, can lead to death. Most patients are under 20 years of age. The spine is more flexible, and it can change the take-off angle of the superior mesenteric vessels from the aorta. The condition is manifested

by intermittent or continuous nausia, vomiting, and abdominal distention leading to dehydration, prostration, metabolic alkalosis, shock, and oligiria.

Symptoms can occur at any time after casting and up to 12 weeks thereafter, but most occur within 2 weeks. Marked weight loss can be a factor. A flat plate study of the abdomen will usually show dilatation of the stomach and duodenum. An upper gastrointestinal series will confirm the diagnosis. In this review, 3 case reports are given, all on teenagers. All recovered when the duodenal compression was relieved.—Arch H. Hall, M.D.

LÉGER, LUCIEN, LEMAIGRE, G., and LÉNRIOT, J.-P. Kystes sur hétérotopies pancréatiques de la paroi duodénale. (Cysts in the duodenal wall associated with ectopic pancreatic tissue.) Presse méd., Oct., 1974, 3, 2309–2314. (Address: Pr. Lucien Léger, Clinique Chirugicale de l'Hôpital Cochin, 27, rue du Faubourg Saint-Jacques, F 75674 Paris, Cedex 14, France.)

Several small cysts in the descending duodenum wall have been incidentally discovered in 25 per cent of duodenopancreatectomies performed by the authors for chronic pancreatitis. All 8 of these cases had a similar histologic appearance. Three of them showed definite ectopic pancreatic tissue in the immediate neighborhood, I cyst contained active trypsin, and another contained lipase, amylase, and elastase in its liquid.

The descending duodenum was entered in 33 operations performed for non-tumoral lesions with clinical chronic pancreatitis. In 8 male patients, ages 35-52, 1-2 cm. cysts were found near the papilla, centered in the submucosa of the duodenum. Seven of these 8 abdomens showed roentgenographic pancreatic calcifications. There were no revealing roentgen findings from the cysts in the 3 duodenums studied with barium. The cysts usually contained no epithelial border, but instead were surrounded by a granulomatous mostly mononuclear inflammatory tissue, with many histiocytes.

The authors believe that the cyst formation arises secondary to chronic pancreatitis and its inflammatory effects.—Alan E. Oestreich, M.D.

Heidenreich, Arturo, Astiz, Juan M., and Demarco, Roberto. Invaginacion intestinal en el adulto. (Intestinal intussusception in adults.) *Prensa méd. argent.*, Aug., 1974, 61, 759–766. (Address: Dr. Arturo Heidenreich, Departamento de Cirugía, Hospital Salaberry, Buenos Aires, Argentina.)

Intestinal intussusceptions are an infrequent cause of intestinal obstruction in adults: most of them are of the "secondary" type and are due to tumors. This process can occur anywhere along the gastrointesti-

nal-colonic tract. "Primary" ceco-colonic intussusceptions are relatively frequent in certain African tribes, and in Koreans.

The clinical picture is usually that of a recurrent partial obstructive process. The roentgenological examination might show partial of complete obstructive changes, and occasionally the precipitating lesion itself. Colonic intussusception in adults should not be treated by hydrostatic reduction during the barium enema study, as the precipitating lesion usually requires surgical excision.

Seven cases are reported in this article. One was a "primary" jejunal intussusception occurring 8 days post-cholecystectomy. The others were of the "secondary" type due to malignant tumors, lipoma, and intestinal wall hematoma.—Julian B. Alvarez, M.D.

Custer, James R., and Shafer, Rex B. Changes in liver scan following splenectomy. J. Nuclear Med., March, 1975, 16, 194–195. (Address: Rex B. Shafer, M.D., Nuclear Medicine Service, Veterans Administration Hospital, 54th Street and 48th Avenue, S., Minneapolis, Minn. 55417.)

Changes in liver size, shape, position and uptake of the <sup>99m</sup>Tc labeled sulfur colloid in the liver scans done on patients following splenectomy were noted by the authors. Elongation of the left lobe of the liver and migration of the left lobe of the liver into the left upper quadrant occurred. A widening of the division between the right and left lobes of the liver and enlargement of the left lobe of the liver were also found to occur.

Misinterpretation of the above changes can result in reporting false positive information such as a residual or accessory spleen, mass lesion in the porta hepatis or recurrent foci of disease.

Four illustrative cases with scans were presented. —Charles W. Cooley, M.D.

SALVIDEA, JULIO C., DIAZ, GLORIA E., MARTELLA, MARIO O., and STOLOVITZKY, ISRAEL. Angiografía de la hidatidosis abdominal, valor de los signos, patología vascular asociada. (Angiography in abdominal hydatidic disease, value of the signs, associated vascular pathology.) Prensa méd. argent., Aug., 1974, 61, 793-796. (From: Hospital Rawson, Buenos Aires, Argentina.)

Celiac and superior mesenteric angiography were performed in 62 patients suspected of having abdominal hydatid cysts. Fifty-five cases were diagnosed as such and subsequent surgery showed that 4 of these patients had non-hydatic cysts. The majority of the cysts were in the liver, 3 were splenic, 5 were renal, and I was peritoneal. One patient had cysts in the liver and kidney, and I had cysts in the spleen and liver.

The angiographic findings (avascular mass displacing the adjacent vessels) were considered to be non-specific; a pericystic halo, occasionally seen, is not pathognomonic. Evidence of portal hypertension was found in 22 per cent of the cases. Intrinsic arterial abnormalities (irregularity, narrowing, occlusion) were found in 67 per cent of the cases. The authors suggest that these changes are indicative of immuno-allergic arteritis secondary to the parasitic infestation.—Julian B. Alvarez, M.D.

KIMMIG, J. M., and PETZEL, H. Hinweise auf die akute und chronisch rezidivierende Pankreatitis bei der hypotonen Duodenographie. (Clues to the acute and chronic recurrent pancreatitis from hypotonic duodenography.) Med. Welt., Oct., 1974, 25, 1732–1735. (Address: Dr. J. Kimmig, Med. Klinik Bad Cannstatt, 7 Stuttgart 50, Priessnitzweg 24, Germany.)

Hypotonic duodenography has proved valuable in the diagnosis of acute and chronic recurrent pancreatitis. The procedure can be simply performed with ingested barium and antispasmodic medication. The gas content of the stomach may thereby be maneuvered into the duodenum for effecting a double contrast. This method, however, can only be partly successful as minute changes are rarely recognized. For optimal results, the original intubation technique with meticulous attention to details is described:

A duodenal tube is introduced into the stomach after the pharynx has been anesthetized with a Xylocaine spray. As the tube approaches the pylorus an indwelling stilet is slightly withdrawn. The pyloric

passage is now facilitated by a right lateral recumbent position and manual palpation of the patient. When the tip of the tube reaches the junction of the second and third portions of the duodenum, the stilet is completely removed and 20 ml. of a 2 per cent solution of Xylocaine is instilled.

After the patient has remained in the right lateral recumbent position for 30 minutes, 20 mg. of Buscopan, an effective antispasmodic, is injected intravenously and secretions of the duodenum are aspirated. A suspension of 125 ml. Micropaque is now injected with the patient in the supine position and 2 roentgenograms are obtained, followed by aspiration of excess barium and a slow injection of adequate amounts of air with the patient turned to the left.

With the resulting roentgenograms, the diagnosis of acute and chronic pancreatitis has been established in 100 consecutive cases. This group also includes an occasional underlying tumor with an inflammatory reaction of the surrounding tissues. Two examples covering the acute and chronic phase of pancreatitis are illustrated.

In acute pancreatitis, periglandular edema causes minute indentations of the medial wall of the C-loop of the duodenum. Kerckring folds are thickened and form an inverted "3" sign. In chronic pancreatitis, smooth indentations with double contours are constantly observed. The folds are distorted and appear crowded in both directions so that the wall forms an irregularly crenate border.

Hypotonic duodenography is not a routine procedure and requires specific indications. It is time-consuming, as meticulous attention to technical details is required for optimal results.—Ernest Kraft, M.D.



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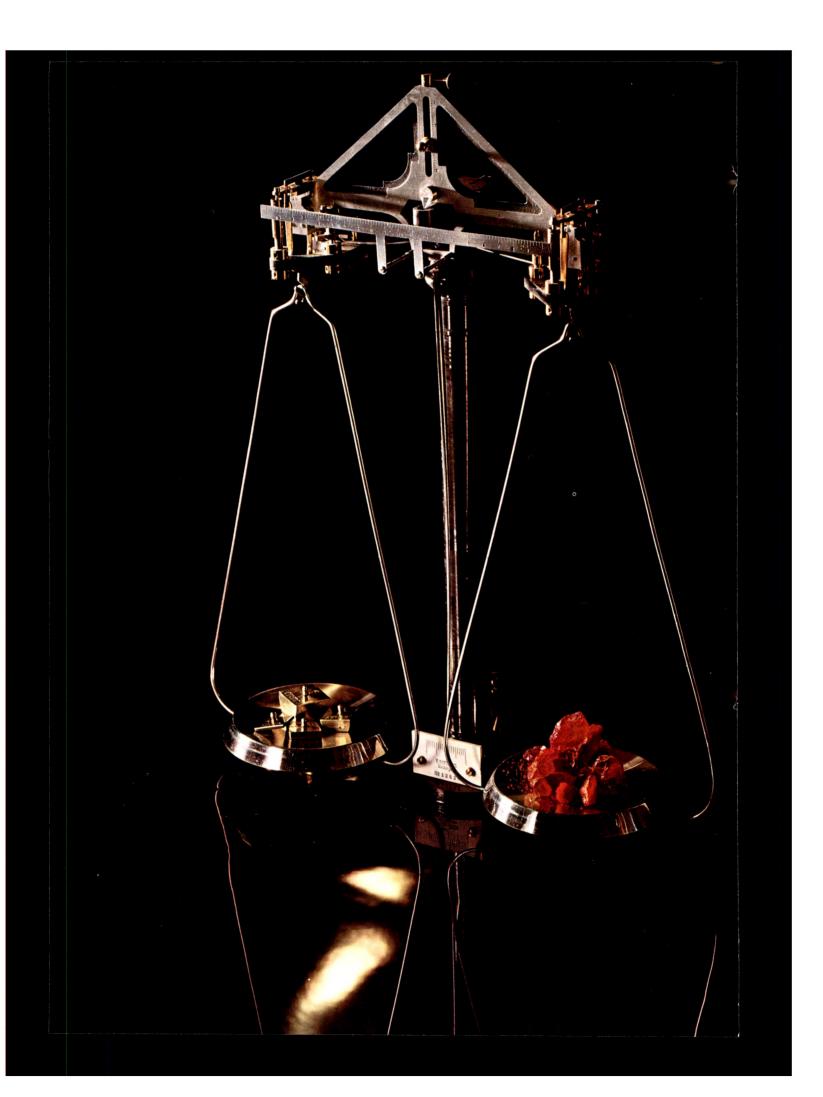
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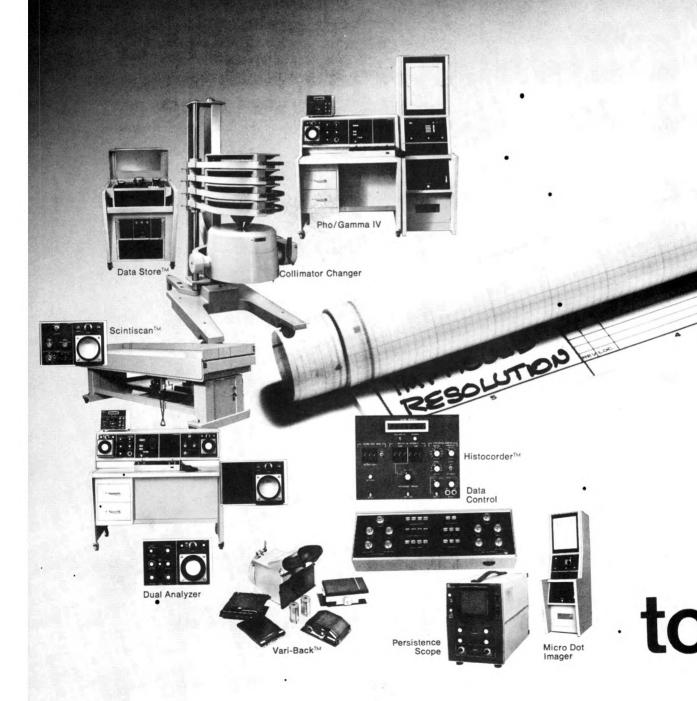
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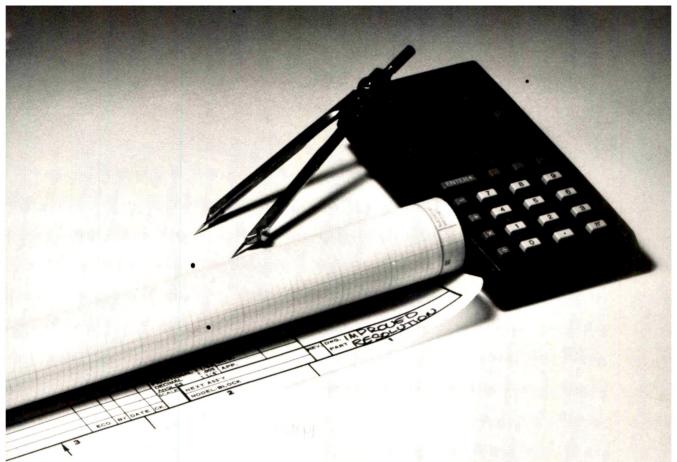
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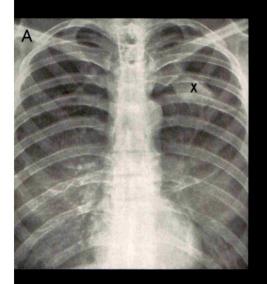
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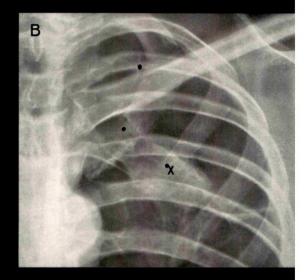
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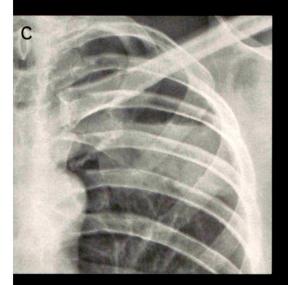
# Carcinoma of the Lung

## "A Few Oddities."

According to the literature, squamous cell cancers account for the majority of primary lung neoplasms. Not unexpected, therefore, are its strange roentgen manifestations. Now for a few examples.





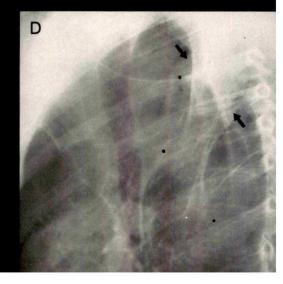


CASE I—This 45-year-old man was asymptomatic.

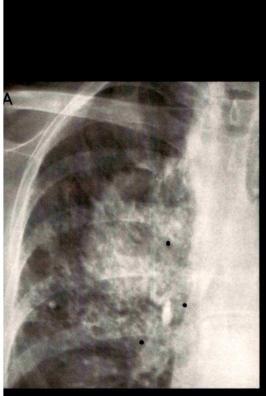
A routine roentgen study, Fig. A, reveals emphasematous blebs in both upper lobes. A mass (x) lines part of the bleb in the left upper lobe. Fig. B demonstrates the mass more closely.

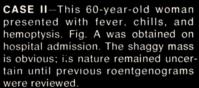
Three months later, Fig. C, a fluid level obscures

Three months later, Fig. C, a fluid level obscures the mass. Fortunately, it is well demonstrated (arrows) in the lateral exposure, Fig. D.



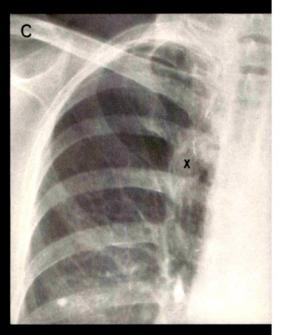
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In retrospect, Fig. B, a chest study exposed 16 months prior to Fig. A revealed a linear mass in the right upper lobe (arrow). This mass was even more obvious two months later, Fig. C (x).







Diagnosing lung disorders like these calls for consistently excellent radiography.

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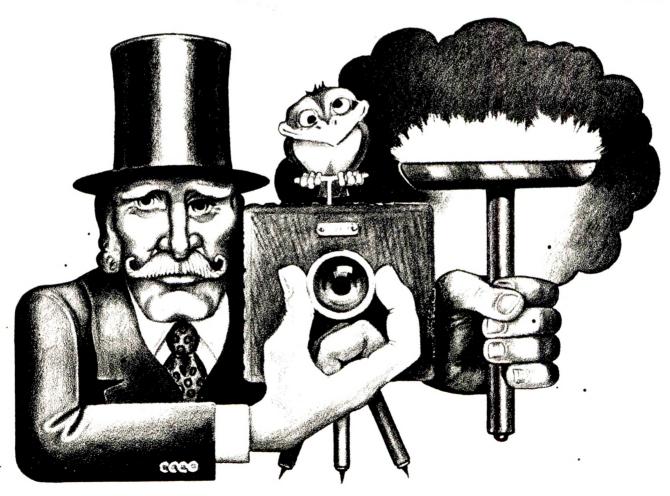
For the sake of the future, "Give to the college of your choice. Now." Who knows what billion-dollar business of tomorrow is germinating on some college campus today.

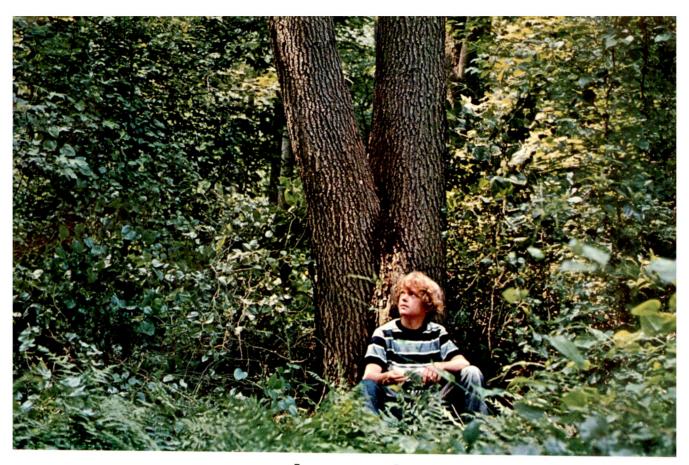
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A STUDY GUIDE IN NUCLEAR MEDICINE: A Modern Up-to-Date Presentation compiled and edited by Fuad. Ashkar, August Miale, Jr., and William Smoak, all of the Univ. of Miami, Miami, Florida. (22 Contributors) Presented in this volume are the lectures featured at the Fourth Annual Nuclear Medicine Seminar which was designed to be a comprehensive review of nuclear medicine. The symposium covered such topics as interaction of gamma rays with matter, control of radiation exposure to man, basic mathematics of nuclear medicine, electrolytes and body composition, essentials of rectilinear scanning and other topics. '75, 488 pp., 312 il., 44 tables, cloth-\$22.75, paper-\$17.50

LYMPHOPROLIFERATIVE DISEASES compiled and edited by David W. Molander, Memorial Hospital for Cancer and Allied Diseases, New York. (23 Contributors) A compilation of the known facets of lymphosarcoma and related diseases is presented in this volume along with pathologic anatomy, immune mechanisms, clinical diagnosis and treatment employing irradiation and chemotherapy. The use of isotopes in managing this disease as well as in the diagnosis of occult foci of the disease is also covered. In the chapter dealing with the pathology of malignant lymphomas the new terminology, non-Hodgkin's malignant lymphoma, is used and new pathologic designations are included. '75, 592 pp. (6 3/4 x 9 3/4), 256 il. (9 in full color), 45 tables, \$39.50

THE PHYSICS OF RADIOLOGY (3rd Ed., 3rd Ptg.) by Harold Elford Johns and John Robert Cunningham, both of the Univ. of Toronto, Toronto, Canada. The emphasis of this Third Edition has been shifted from 200 kv and caesium 137 radiation, towards higher energy radiations. Computers are finding an ever-increasing application in calculations of dose distributions in radiotherapy; therefore, numerous sections devoted to computer techniques have been added. A section has also been added dealing with the solid state dosimeter lithium fluoride. Also introduced are the concepts of kerma, particle fluence and energy fluence with illustrations and examples of these concepts. '74, 812 pp. (6 3/4 x 9 3/4), 398 il., 92 tables, \$24.75

THE HAND ATLAS by Moulton K. Johnson and Myles J. Cohen, both of UCLA, Los Angeles. California. This atlas portrays the anatomy of the hand as the surgeon will encounter it in the operating room - layer by layer, beginning with the skin and ending with x-ray studies of the bones. Photographs of dissections of unembalmed specimens provide more realistic illustrations, all of which are approximately life-size, except where otherwise indicated. With these few exceptions, the anatomical structures shown are as the authors found them. Topics include the distal volar forearm, the palm, thumb, fingers, the radial side of the hand, the dorsum of the hand, spaces of the hand and wrist mechanics. '75, 108 pp. (8 1/2 x 1), 121 il. (8 in color), \$22.00

HEALTH PROTECTION OF RADIATION WORKERS by W. Daggett Norwood, Hanford Environmental Health Foundation, Richland, Washington. The present knowledge regarding the hazards to the safety and well-being of persons working with radiation is summarized. Discussed are established standards for health, safety and environmental protection along with their implementation, diagnosis and therapy for illness or injury. Even though it is addressed primarily to physicians and nurses, teachers, health physicists, occupational hygienists, safety specialists, biologists and others who are concerned with protecting the health and safety of radiation workers, this book will also contribute to the education of the public regarding the hazards of radiation. '75, 468 pp., 16 il., 16 tables, \$27.50

ARTHROGRAPHY OF THE SHOULDER: The Diagnosis and Management of the Lesions Visualized by Julius S. Neviaser, George Washington Univ. Medical School, Washington, D. C. Writing to encourage the use of arthrography, the author passes on lessons learned in performing over 3,000 arthrographies and the knowledge of the anatomy of the shoulder gained at postmortem examinations and in the operating room. The author believes that arthrography of the shoulder offers more real clinical information than performing this procedure on any other joint. '75, 288 pp., 265 il., \$22.50

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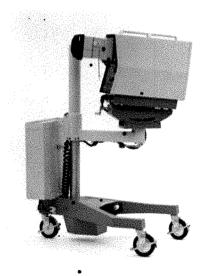
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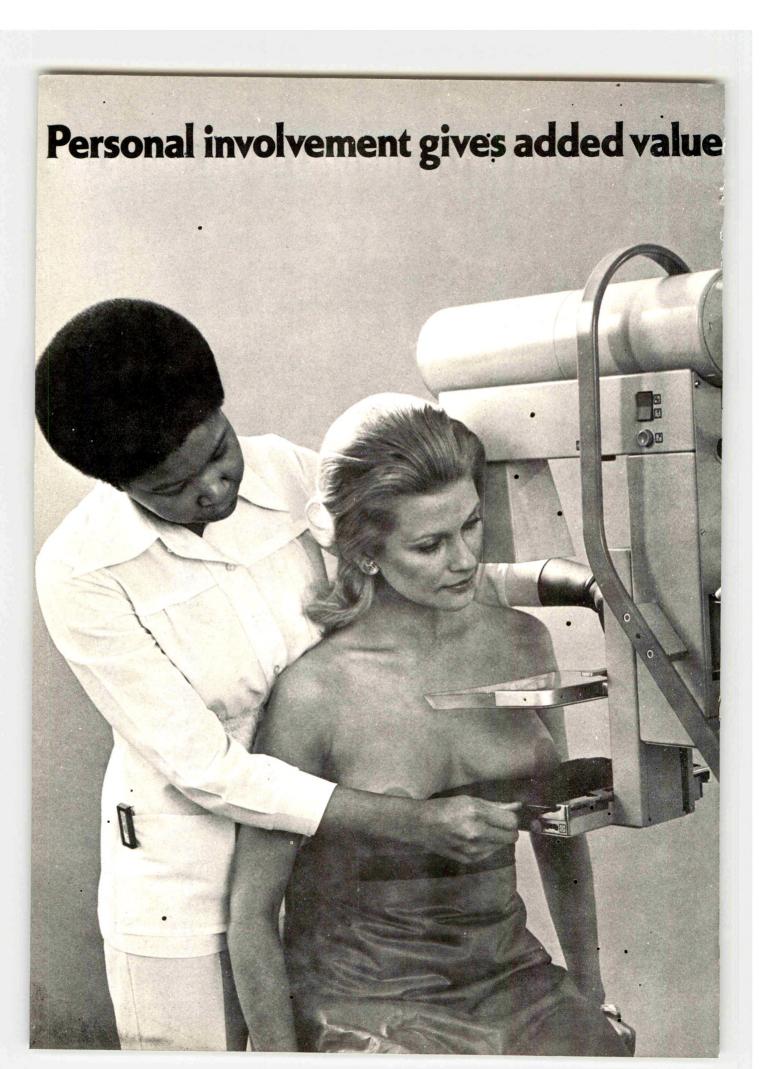
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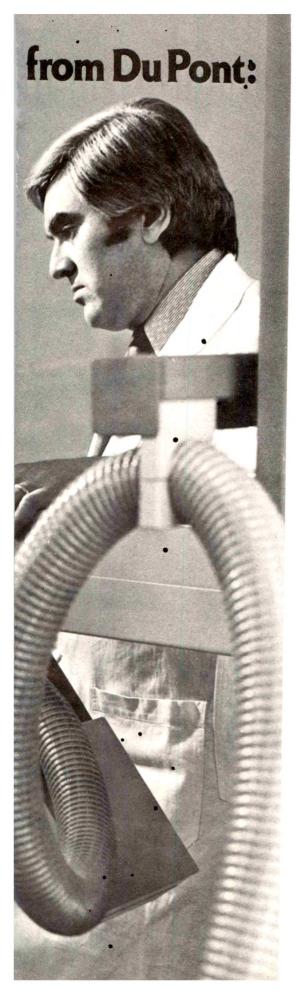
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# Spectrotherm 2000







"We've developed the Lo-dose Mammography System that reduces patient exposure over 85% and still delivers excellent diagnostic clarity."



Left to right:

Bernard J. Ostrum, M.D., Chairman of Department of Diagnosis, Albert Einstein Medical Center, Philadelphia.

R. E. Wayrynen, PhD., X-ray Technical Manager, Du Pont Company.

Harold J. Isard, M.D., Chairman of Division of Radiology, Albert Einstein Medical Center, Philadelphia.

In the late 1960's, Drs. Isard and Ostrum were looking for a better way to perform mammography—one with lower patient risk than conventional systems. They came to Du Pont for help.

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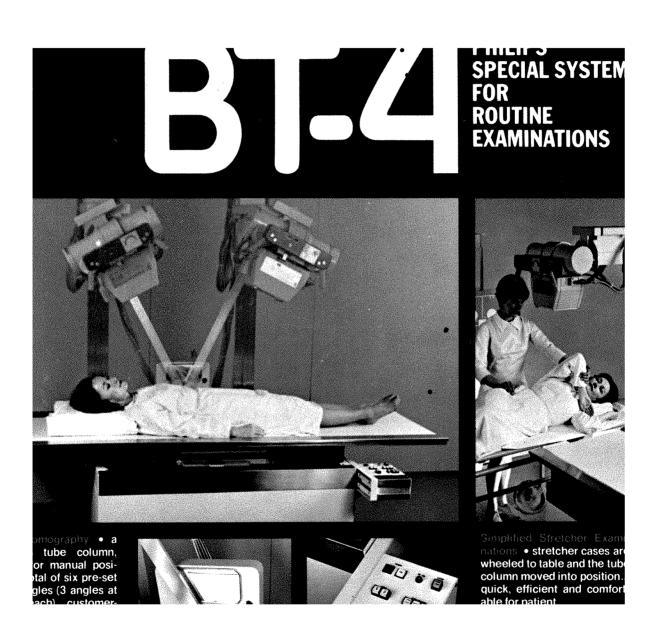


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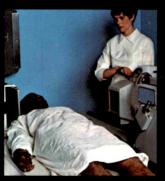




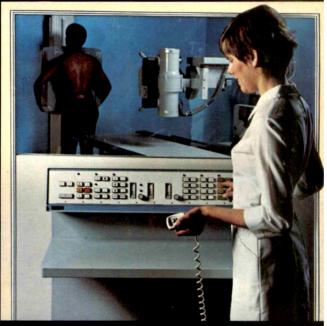
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## If these six people don't impress you, naybe the companies who hired them will.













These people aren't actors. They are real people doing real jobs for

real companies.

Take Joseph Minikovsky, for example (top left), an electronic maintenance engineer. He has learned to use one hand the way most people in his field have to use two. As quickly, as efficiently, as accurately. He's a crackerjack technician and the National Broadcasting Company knows it. Yes, he works for NBC.

Robert Thompson (top center) is a mechanical engineer. At Syska & Hennessy in New York.

Frank Gaal (top right), a machine operator for Con Edison.

James Withers (bottom left), an administrative assistant with

Control Data Corporation.

Mildred Hudson (bottom center), a coding and terminations clerk for Standard Security Life Insurance.

And Thomas Clancy (bottom right) is one of the best computer programmers New York University ever had.

They're all working. At jobs they enjoy. For companies who are very grateful to have them.

You see, despite their obvious disabilities, these people are skilled, hard-working men and women. And traits like that are hard to come by these days. (Ms. Hudson's supervisor told us she was one of only three people in their company who made it to work

during a heavy snowstorm.)

It takes a lot of determination and many months of rehabilitation to get where these people are.

But it takes very little more than a letter to find people like them and hire them.

The Director of Vocational Rehabilitation in your state has a file of skilled, trained, rehabilitated people in every field. Ready, willing and able to work.

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Write the Director of Vocational Rehabilitation in your State Capital.



Hand: Normal density setting. Focal spot 1.2mm. Center field. 500ma. 60kVp.



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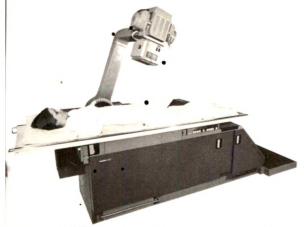
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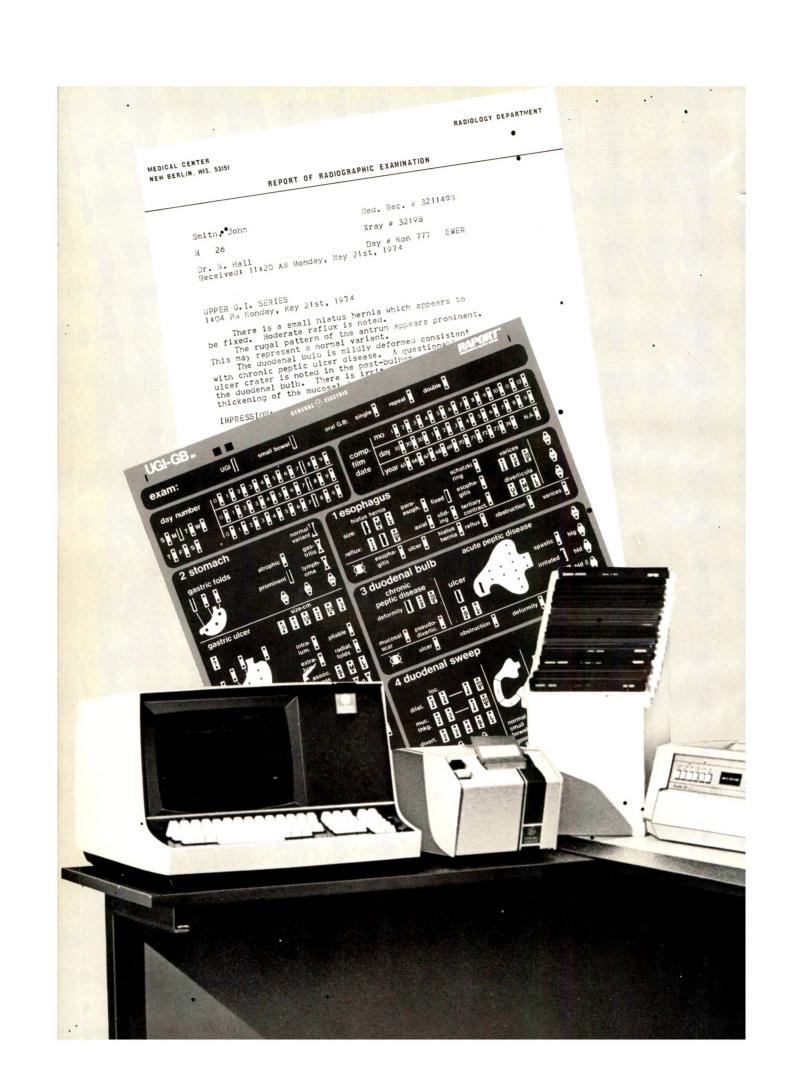
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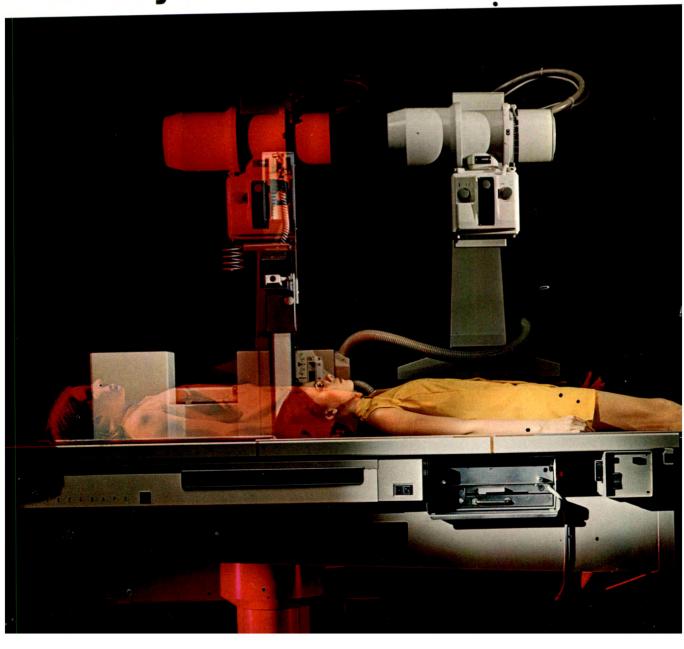
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ELEMENTS OF RADIATION PROTECTION by Ronald V. Scheele and Jack Wakley, both of the Univ. of Virginia School of Medicine, Charlottesville, Virginia. Information in this textbook includes atomic structure, ionizing radiation, interaction of radiation with matter, sources of radiation exposure, biological manifestation of radiation exposure, permissible dose limits, principles of radiation protection and monitoring devices. Several chapters of the book deal with federal performance standards and Atomic Energy Commission regulations. The material content and mode of presentation are clear and nonmathematical for those students who have little background in physics and mathematics. '75, 112 pp., 15 il., 10 tables, \$7.95, paper

XERORADIOGRAPHY OF THE BREAST (3rd Ptg.) by John N. Wolfe, Hutzel Hospital, Detroit, Michigan. Foreword by Wendell G. Scott. Written primarily for the radiologist but of interest to others working in the field of breast cancer, this text presents a significant and newer method for early detection of breast cancer in more detail and in greater contrast than can be obtained in x-ray film. Breast anatomy and normal breast are discussed, providing a thorough understanding essential to achieve the proper technique and correct interpretation of the xeromammogram. An up-to-date discussion of benign conditions, miscellaneous conditions, and malignancies is included. '75, 194 pp. (8 1/2 x 11), 242 il. (92 in color), \$23.50

INDICATIONS AND ALTERNATIVES IN X-RAY DIAGNOSIS: A Guide to the Effective Employment of Roentgenologic Studies in the Solution of Diagnostic Problems (2nd Ed.) by Melvyn H. Schreiber, Univ. of Texas Medical Branch, Galveston, Texas. Emphasis is on providing the reader with a thorough background in the uses to which the ordinary and special x-ray studies may be put, with alternatives emphasized when the indicated examinations cannot be performed or when more than one kind of examination is available for the solution of a specific problem. Indications and contraindications are carefully defined. '74, 192 pp., 98 il., \$11.50, paper

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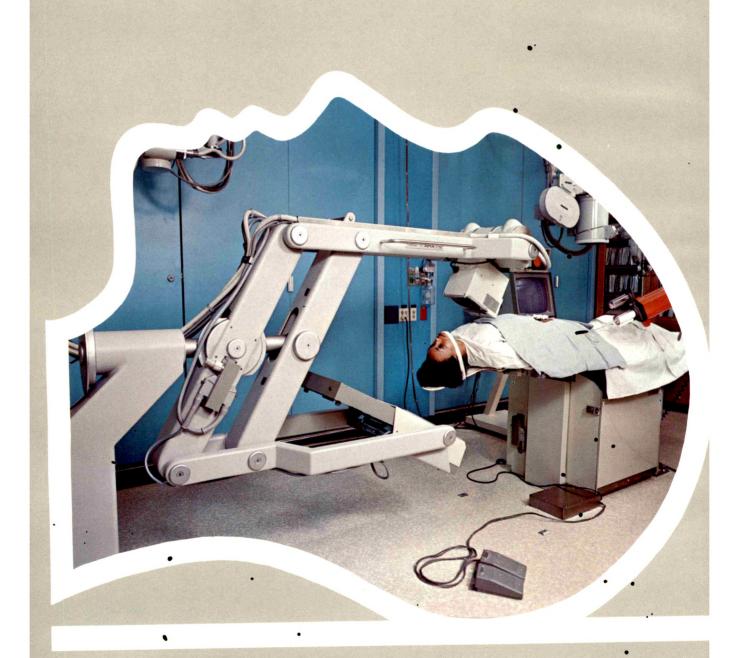
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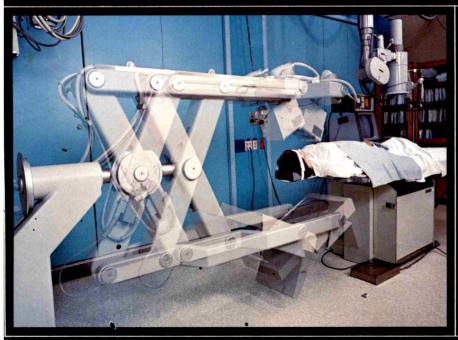
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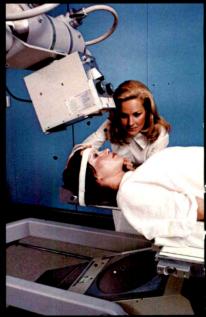
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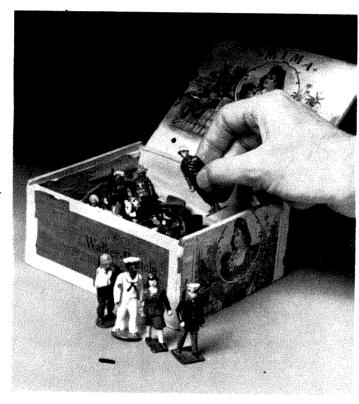
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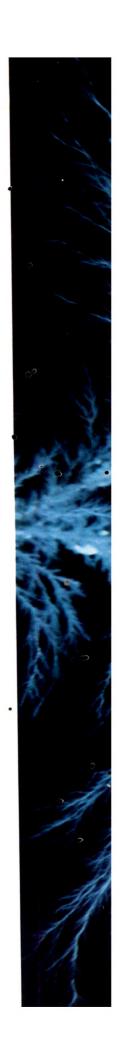
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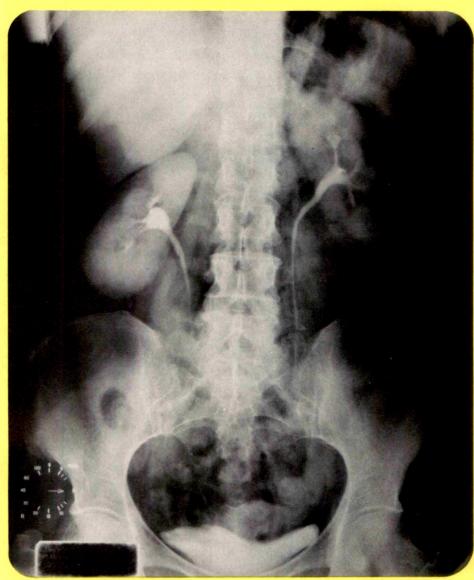
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# THE AMERICAN JOURNAL OF ROENTGENOLOGY, RADIUM THERAPY AND NUCLEAR MEDICINE

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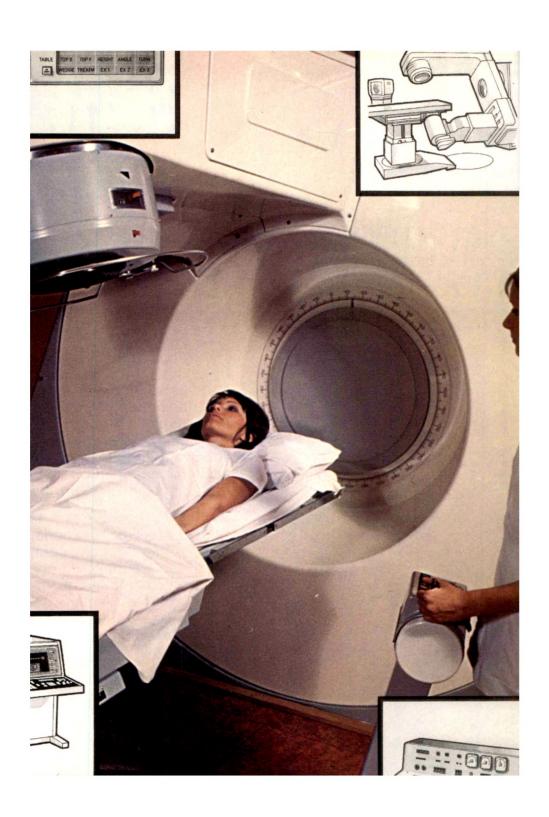
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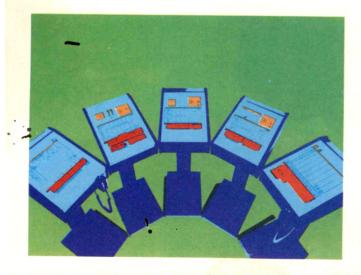
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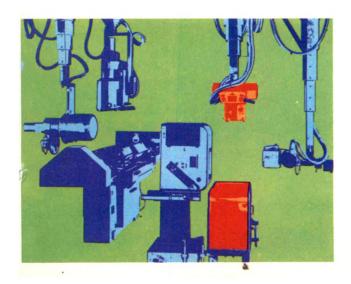
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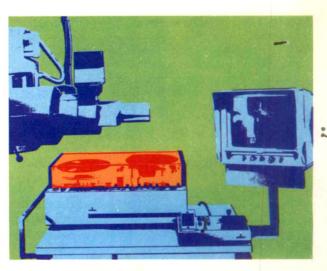
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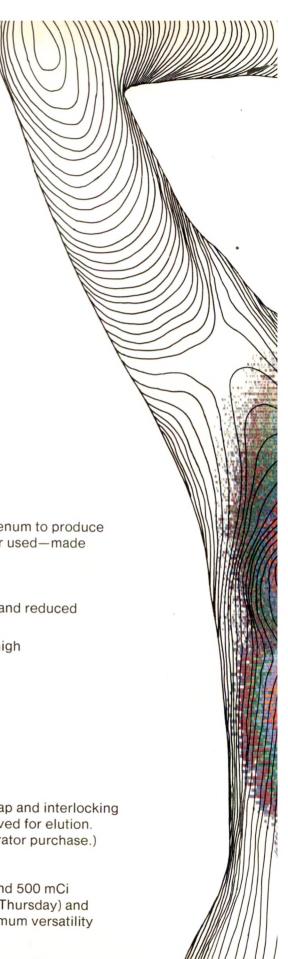
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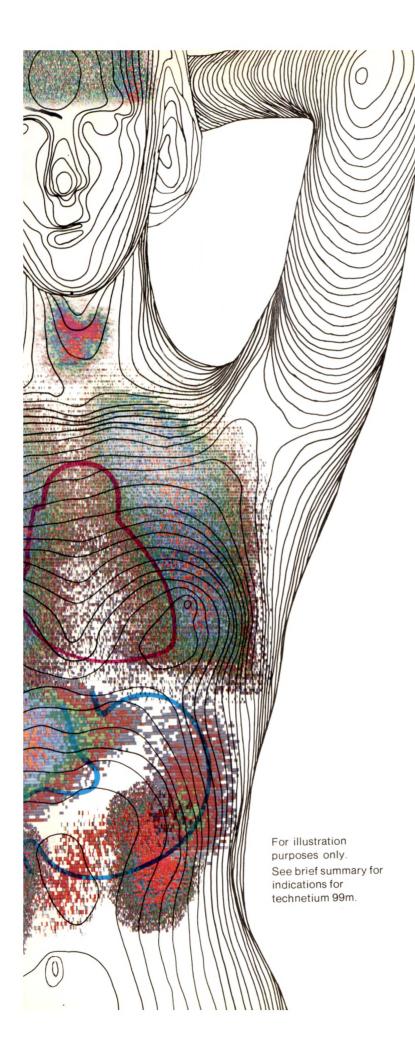
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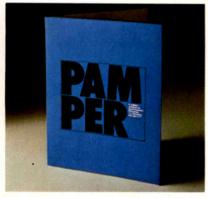


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**CONTRAINDICATIONS:** In patients with a hypersensitivity to salts of diatrizoic acid. Urography contraindicated in patients with anuria.

WARNINGS: A definite risk exists with the use of contrast agents in excretion urography in patients with multiple myeloma. There has been anuria with progressive uremia, renal failure and death. This risk of the procedure in these patients is not a contraindication; however, partial dehydration in preparation for study is not recommended since it may predispose for precipitation of myeloma protein in renal tubules. No therapy, including dialysis, has been successful in reversing this effect. Myeloma should be considered in persons over 40 before undertaking urographic procedures.

In cases of known or suspected pheochromocytoma, if the physician feels that the possible 
benefits outweigh the considered risks, radiopaque 
materials should be administered with extreme 
caution; however, an absolute minimum of 
material should be injected, the blood pressure 
should be assessed throughout the procedure, 
and measures for treating a hypertensive crisis 
should be available.

Contrast media may promote sickling in homozygous individuals when injected I.V. or intra-arterially. Although a history of sensitivity to iodine per se or to other contrast media is not an absolute contraindication, administration of diotrizoate requires extreme caution in such cases. Renografin-76 should be used in pregnant patients only when the physician deems its use essential to the welfare of the patient since safe use during pregnancy has not been established. Perform thyroid function tests prior to administration of Renografin-76 since iodine-containing contrast agents may alter the test results.

Weigh the inherent risks against necessity for performing angiocardiography in cyanotic infants and patients with chronic pulmonary emphysema. In pediatric angiocardiography, a dose of 10 to 20 ml. may be particularly hazardous in infants weighing less than 7 kg.; this risk is probably significantly increased if these infants have preexisting right heart "strain," right heart failure, and effectively decreased or obliterated pulmonary vascular beds. Perform urography with extreme caution in persons with severe concomitant hepatic and renal disease. Perform selective coronary arteriography only in selected patients and those in whom expected benefits outweigh the procedural risk.

PRECAUTIONS: Diagnostic procedures involving use of contrast agents should be performed under the direction of personnel with prerequisite training and a thorough knowledge of the particular procedure. Appropriate facilities should be available for coping with situations which may a rise as a result of the procedure and for emergency treatment of severe reactions to the contrast agent itself; competent personnel and emergency facilities should be available for at least 30 to 60 minutes after I.V. administration since delayed reactions have been known to occur. These severe life-threatening reactions suggest



hypersensitivity to the contrast agent. A personal or family history of asthma or allergy or a history of a previous reaction to a contrast agent warrants special attention and may predict more accurately than pretesting the likelihood of a reaction although not the type nor severity of the reaction in the individual. The value of any pretest is questionable. The pretest most performed is the slow I.V. injection of 0.5 to 1.0 ml. of the preparation prior to injection of the full dose; however, the absence of a reaction to the test dose does not preclude the possibility of reaction to the full diagnostic dose. Should the test dose produce an untoward response, the necessity for continuing the examination should be re-evaluated. If deemed essential, examination should proceed with all possible caution. In rare instances, reaction to the test dose may be extremely severe; therefore close observation and facilities for emergency treatment are indicated.

Renal toxicity has been reported in a few patients with liver dysfunction who were given oral cholecystographic agents followed by urographic agents; therefore, if known or suspected hepatic or biliary disorder exists, administration of Renografin-76 should be postponed following the ingestion of cholecystographic agents. Consider the functional ability of the kidneys before injecting Renografin-76. Use cautiously in severely debilitated patients and in those with marked hypertension. Bear in mind the possibility of thrombosis when using percutaneous techniques.

In excretion urography, adequate visualization may be difficult or impossible in uremic patients or others with severely impaired renal function (see Contraindications). In aortography repeated intraaortic injections may be hazardous; this also applies to pediatric angiocardiography particularly in infants weighing less than 7 kg. (see Warnings). In peripheral arteriography, hypotension or moderate decreases in blood pressure seem to occur frequently with intra-arterial (brachial) injections; this is transient and usually requires no treatment Monitor blood pressure during the immediate 10 minutes after injection. It is recommended that selective coronary arteriography not be performed for about 4 weeks after diagnosis of myocardial infarction; mandatory prerequisites to this procedure are experienced personnel, ECG monitoring apparatus, and adequate facilities for immediate resuscitation and cardioversion

ADVERSE REACTIONS: Nausea, vomiting, flushing, or a generalized feeling of warmth are the reactions seen most frequently with intravascular injection. Symptoms which may occur are chills, fever, sweating, headache, dizziness, pallor, weakness, severe retching and choking, wheezing, a rise or fall in blood pressure, facial or conjunctival petechiae, urticaria, pruritus, rash, and other eruptions, edema, cramps, tremors, itching, sneezing, lacrimation, etc. Antihistaminic agents

may be of benefit; rarely, such reactions may be severe enough to require discontinuation of dosage. There have been a few reports of a burning or stinging sensation or numbness, of venospasm or venous pain, and of partial collapse of the injected vein. Neutropenia or thrombophlebitis may occur. Severe reactions which may require emergency measures (see Precautions) are a possibility and include cardiovascular reaction characterized by peripheral vasodilatation with hypotension and reflex tachycardia, dyspnea, agitation, confusion, and cyanosis progressing to unconsciousness. An allegic-like reaction ranging from rhinitis or angioneurotic edema to laryngeal or bronchial spasm or anaphylactoid shock may occur. Temporary renal shutdown or other nephropathy may occur.

shutdown or other nephropathy may occur.

Adverse reactions as a consequence of excretion urography include cardiac arrest, ventricular fibrillation, anaphylaxis with severe asthmatic reaction, and flushing due to generalized vasodilatation. Risks of aortography procedures include injury to aorta and neighboring organs, pleural puncture, renal damage (including infarction and acute tubular necrosis with oliguria and anuria), accidental selective filling of right renal artery during translumbar procedure in presence of preexistent renal disease, retroperitoneal hemorrhage from translumbar approach, spinal cord injury and pathology associated with syndrome of transverse myelitis, generalized petechiae, and death following hypotension, arrhythmia, and anaphylactoid reactions. In pediatric angiocardiography, arrhythmia and death have occurred. During peripheral arteriography, hemorrhage from puncture site, thrombosis of the vessel, and brachial plexus palsy (following axillary artery injection) have occurred. During selective coronary arteriography and selective coronary arteriography with left ventriculography, transient ECG changes (most patients); transient arrhythmias (infrequent); ventricular fibrillation (from manipulation of catheter or administration of medium); hypotension; chest pain; myocardial infarction; transient elevation of creatinine phosphokinase (occurred in about 30% of patients tested); fatalities have been reported; hemorrhage, thrombosis, pseudoaneurysms at puncture site, dislodgment of arteriosclerotic plaques, dissection of coronary vessels, and transient sinus arrest have occurred due to the procedure.

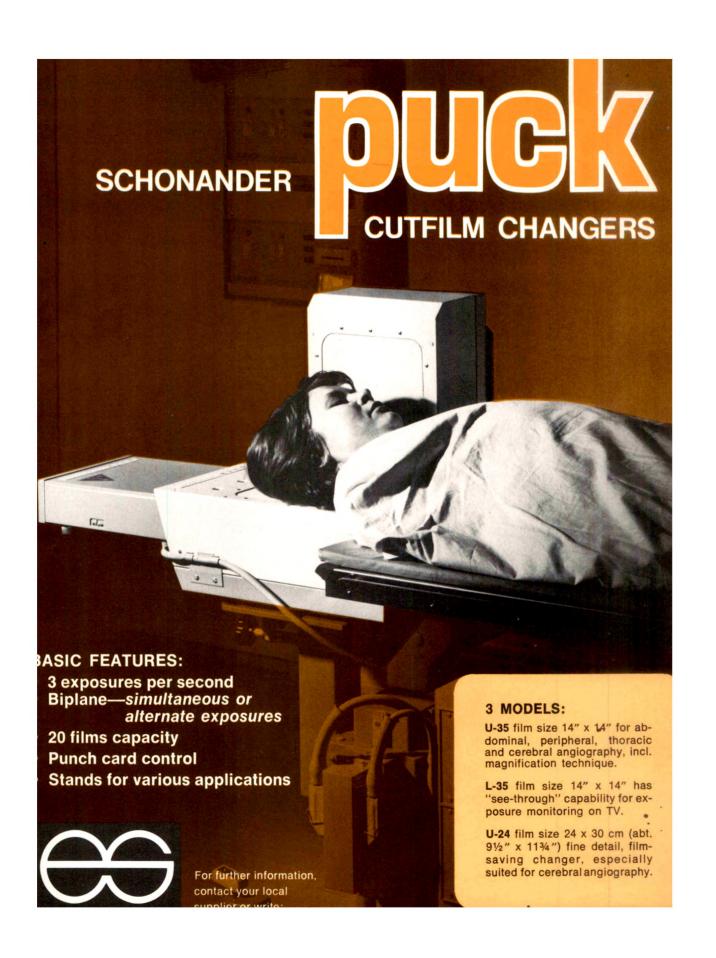
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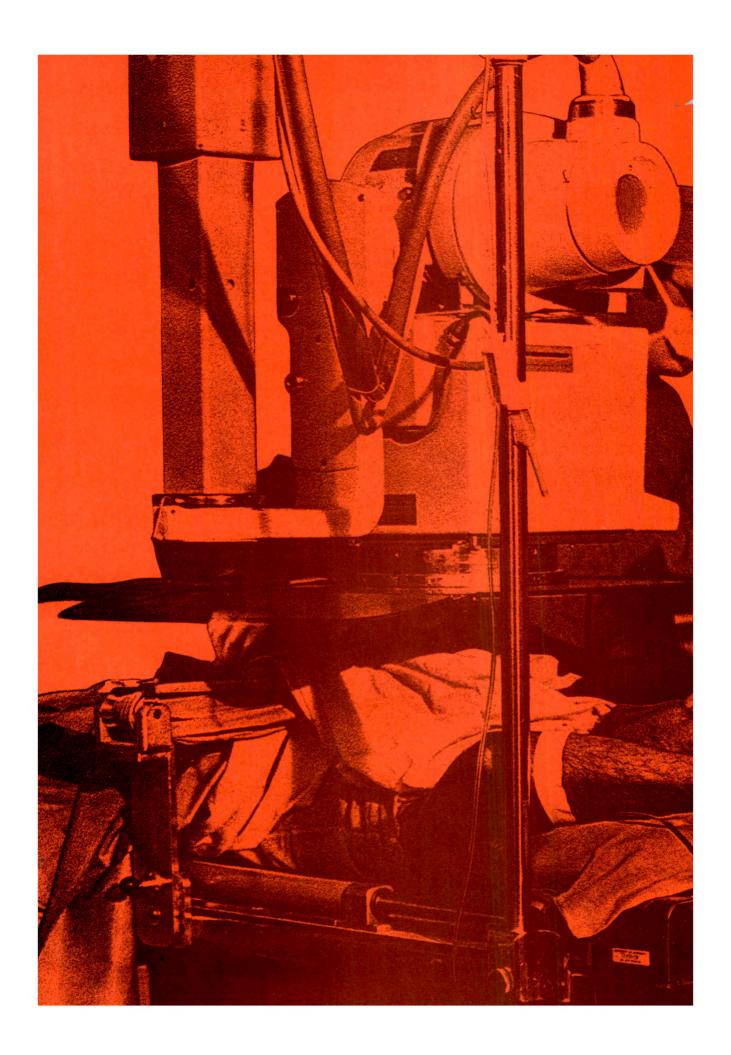
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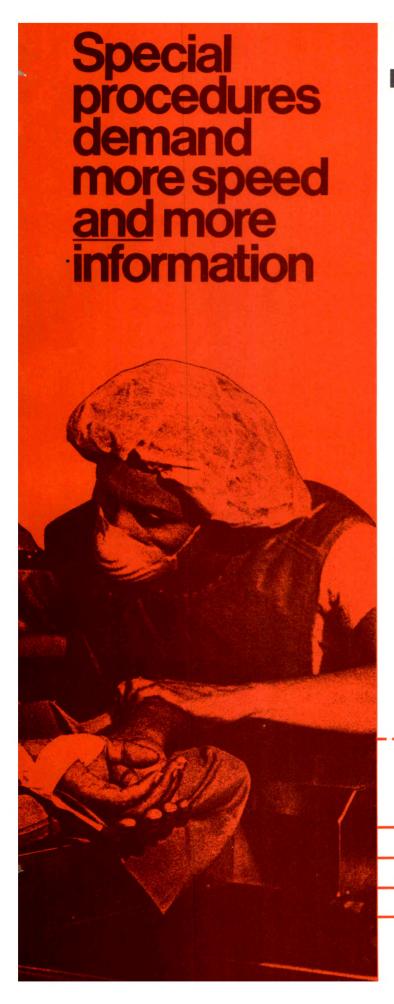
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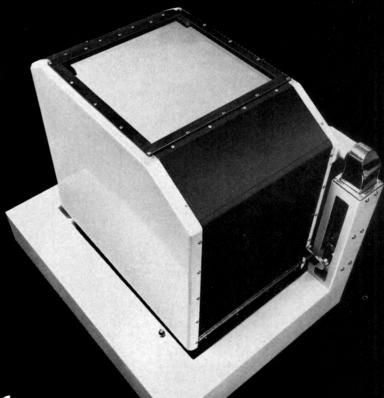


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## THE AMERICAN JOURNAL OF ROENTGENOLOGY RADIUM THERAPY AND NUCLEAR MEDICINE

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MAY, 1975

No. 1

### IMPLANTED RADIO-FREQUENCY ELECTRONIC STIMULATORS\*

By LEONID CALENOFF, M.D., and GERALD D. KRUGLIK, M.D. CHICAGO, ILLINOIS

RECENT technologic advances in biophysics have made possible the clinical development of radio-frequency electronic stimulators for a wide variety of clinical uses.<sup>13</sup>

Contrary to the implantation of a cardiac pacemaker, wherein the electrodes and battery are entirely implanted within the patient, the new electronic stimulators are only partially implanted. The external parts are a radio-frequency transmitter and a transmitting antenna. The transmitter power source can be easily replaced, obviating the operative procedure required to replace the battery of a cardiac pacemaker.

Implanted electronic stimulators have passed the stage of experimentation and one may now encounter such devices on chest roentgenograms. Radiologists are requested to assess implantation of such devices. Familiarity is therefore required.

Three implanted radio-frequency electronic stimulators apparent on chest roent-genograms will be illustrated and their function and application briefly discussed:
(1) The Dorsal Column Stimulator; (2)

The Carotid Sinus Nerve Stimulator; and (3) The Phrenic Nerve Stimulator.

### COMPONENTS

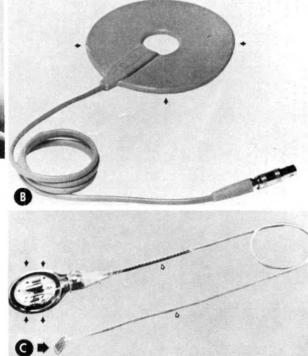
Radio-frequency electronic stimulators consist of 4 components: (1) a radiofrequency transmitter; (2) a transmitting antenna; (3) a radio-frequency receiver; and (4) a stimulating lead (Fig. 1, A-C). The battery operated transmitter and antenna are worn externally while the receiver and lead are implanted in the patient's chest. The transmitter supplies stimulating power to the receiver by inductive coupling through the skin. The antenna is placed on the patient's skin directly over the implanted receiver. The receiver shapes the radio-frequency signals into an appropriate wave form and applies this pulse via the electrode attached to the organ.

There are different manufacturers of implanted radio-frequency electronic stimulators, but they are all built and operate by the same principle.

<sup>\*</sup> From the Department of Radiology, Northwestern Memorial Hospital and the McGaw Medical Center of Northwestern University, Chicago, Illinois.



Fig. 1. Components of a radio-frequency electronic stimulator. (A) Radio-frequency transmitter. The transmitter contains a pulse generating circuitry, radio-frequency transmitting circuitry and a 9 volt battery. It is usually carried by the patient on a belt or in his pocket. (B) Antenna. The transmitting antenna is an outside component. The disk of the antenna (arrows) is placed on the patient's skin directly over the implanted receiver. (C) Implanted component of the stimulator. The receiver (black arrows) is a waferlike device containing receiving circuitry and pulse shaped frequency. The compo-



nents of the receiver are embedded in epoxy resin covered with medical grade silicone rubber. It is implanted subcutaneously usually below the clavicle or on the anterior chest wall. The lead (open arrows) is pre-attached to the receiver and to the electrode head (large black arrow). The electrode head is constructed of polyester reinforced silicone rubber and is usually sutured or clipped to the nerve to be stimulated.

The above illustrated components, a prototype of all other radio-frequency electronic stimulators, is the MYELOSTAT<sub>TM</sub> Dorsal Column Stimulator. (Reproduced with permission by Medronic Inc.)

### DORSAL COLUMN STIMULATOR

The most popular radio-frequency electronic stimulator is the dorsal column stimulator used in patients with intractable pain in whom multiple attempts have failed to provide relief.

The case of a 24 year old woman is illustrated in Figure 2. The basis for the use of implanted electronic stimulators to alleviate pain is based on the "gate theory" of Melzack and Wall. According to this theory, all pain information travels through the spinal cord via small nonmyelinated (gamma-delta) fibers. The sensation of touch, on the other hand, travels through the spinal cord via large A-betta fibers, the stimulation of which is never painful. Both types of fibers project to the substantia gelatinosa and the transmission cells in the dorsal horn. The substantia gelatinosa acts as a gate control system

that modulates the synaptic transmission of nerve impulses from peripheral fibers to central cells. Although mild pain can be controlled by stimulating peripheral nerves, intractable pain, which arises from large injured areas, is not thus controlled. Shealy et al.<sup>12</sup> showed that if the dorsal column of the spinal cord is stimulated, the pain threshold can be significantly increased. In 1970 they reported the first 6 successful dorsal column stimulator implants. The patients had pain from carcinoma, trauma, multiple sclerosis and meningeal scarring of the lumbar area.

In response to stimulation of the dorsal column, there is a buzzing and tingling sensation which radiates throughout most of the body below the level of the insertion of the electrode. Clinical results indicate that relief from pain occurs in areas where buzzing is felt during stimulation.<sup>11</sup>

The technique of insertion of the dorsal column stimulator is a modified bilateral laminectomy at the level of T2–T3; an intradural pouch is created to receive the stimulator electrodes.<sup>2</sup> The subarachnoid space is never entered and the electrode is supported in such a manner that spinal cord compression is avoided. The receiver is placed subcutaneously below the clavicle and through a tunnel created under the skin. The electrode is passed into the cervical area to be placed in the prepared intradural pouch.

The implantation of the dorsal column stimulator is not without complications. Fox<sup>5</sup> studied 600 cases done by 10 neurosurgeons across the country. Between 20 and 65 per cent of the patients were happy with the results, based upon the neurosurgeons queried and their criteria for "success." The most significant complications relate to spinal cord injury, cerebrospinal fluid fistulas and direct physical damage to lead wires or electrodes during implantation. The antenna is the most common site of electronic malfunction; however, the antenna is easily replaced.

### CAROTID SINUS NERVE STIMULATOR

During periods of physical or emotional stress, the myocardial oxygen requirement may exceed the ability of diseased coronary arteries to provide sufficient oxygen, resulting in angina pectoris.

Electrical stimulation of the neural receptors of the carotid sinus wall reduces the systemic vascular resistance, causing a reduction in the systemic arterial blood pressure, decrease in myocardial oxygen consumption and relief of angina.<sup>3,8</sup>

Electronic stimulators of the carotid sinus nerves were first inserted in humans by Bilgutay and Lillehei in 1965.<sup>1</sup> The stimulator as well as the single pole generator were implanted. A magnetic on-off switch was placed on the skin above the subcutaneously implanted generator. Radio-frequency electronic stimulators have been in use since 1967.<sup>3</sup>

The case of a 52 year old plumbing con-

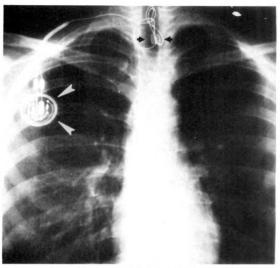
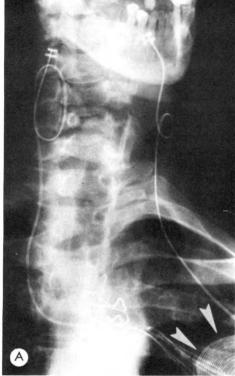


Fig. 2. Dorsal Column Stimulator. A dorsal column stimulator was implanted is a 24 year old woman who suffered intractable lower back pain resulting from a Judo accident. The chest roentgenogram was obtained postoperatively to document the position of the stimulator. The electrode head (black arrows) is shaped like an "E" pointing vertically. It has been sutured in a dural pocket at the level of T2-T3. Note the laminectomy defect. The receiver (white arrowheads) is implanted subcutaneously on the anterior chest wall. Note the slack in the electrode lead, needed to prevent avulsion, when the patient is bending down or making other excessive motions.

tractor is illustrated in Figure 3, A-C.

According to Epstein et al.,3 implantation of a carotid sinus nerve stimulator is carried out after the following criteria are fulfilled: an incapacitating angina is present and not satisfactorily controlled by an optimal medical program; coronary angiography reveals the presence of coronary artery narrowing; an exercise capacity can be increased after nitroglycerin; and finally, intact baroreceptor reflexes are present and documented by a response to the Valsalva maneuver.

The surgical procedure itself requires an incision below the clavicle with creation of a pocket large enough to hold the receiver. Two more incisions are made on both sides of the thyroid cartilage, the carotid sheath is incised and the carotid sinus nerve identified. The 2 incisions are connected with subcutaneous tunnels. After



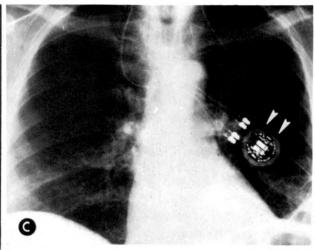




Fig. 3. Carotid Sinus Nerve Stimulator. Implanted in a 52 year old plumbing contractor who suffered from severe angina pectoris. He had undergone 2 coronary bypass surgeries without relief from the angina.

 $(\mathcal{A} \text{ and } \overline{B})$  Anteroposterior and lateral views of the neck show the electrode head sutured in place around the carotid sinus nerve (black arrows). The electrode leads are double on each side with 4 leads reaching the receiver. Note the slack in the lead permitting the neck to turn without displacement of the electrode. (C) The receiver of the stimulator is implanted subcutaneously on the left anterior chest wall (small white arrowheads). During filming of the neck  $(\mathcal{A})$ , the patient had placed the antenna over the receiver. This is the coil-spring structure on the left anterior chest wall (large white arrowheads).

the stimulator is inserted, the carotid sinus nerves on each side are placed in the electrode unit.

The carotid sinus nerve electronic stimulator functions very much like the dorsal column stimulator. The patient places the antenna on the skin directly above the

receiver; radio-signals are sent via a transmitter carried in his pocket or attached to his belt.

The results are, in general, favorable.<sup>3,4,8</sup> Severe angina can be terminated by activation of the stimulator, which progressively encourages the patient toward more activ-

ity. However, when extremely stressful situations exist, such as rapid walking or very cold weather, the stimulation may not be sufficient to relieve the angina.

Insertion of a carotid sinus nerve electronic stimulator is not without hazards. Two out of 17 patients in Epstein's group,<sup>3</sup> died intraoperatively. One patient suffered a myocardial infarct after surgery, a second suffered a complete bilateral hypoglossal nerve paralysis with recovery, while a third had a transient cervical root palsy.

### PHRENIC NERVE STIMULATOR

Interest in stimulating the phrenic nerve to produce diaphragmatic motion had decreased since the decline of poliomyelitis. In recent years, however, there has been a renewed interest to electronically assist respiration in two conditions: primary hypoventilation and quadriplegia.

Since approximately 100 times the energy required for cardiac stimulation is required even for unilateral phrenic nerve stimulation, it was clear that no totally implantable source could function for an acceptable period of time. Radio-frequency stimulation is therefore an attractive means for long-term stimulation.

The radio-frequency phrenic nerve electronic stimulator operates the same way as the dorsal column and carotid sinus nerve stimulators. The electrodes and the receiver are implanted, the antenna and transmitter are external.

Figure 4 illustrates the case of a 17 year old male patient involved in a diving accident.

Patients with primary hypoventilation have a respiratory center lesion. They need respiratory assistance, especially at night because of the insensitivity of the respiratory center to carbon dioxide. The respiratory center in quadriplegic patients has a normal sensitivity to carbon dioxide but there is no continuous movement of the diaphragm. Because there is fatigue of the diaphragm noted after 12–18 hours of stimulation and because after 24 hours of stimulation the diaphragm contracts only



Fig. 4. Phrenic Nerve Stimulator. Implanted bilaterally in a 17 year old male patient who had suffered a compression fracture of C4 with resulting quadriplegia. A bedside roentgenogram of the chest taken immediately after insertion of the stimulators shows the electrode heads held next to the phrenic nerve by vascular clips (black arrows). The leads implanted under the skin (white arrowheads) terminate on the anterior chest wall, as seen on the left side (large black arrow). A receiver was implanted and connected to the leads a few days subsequent to the chest roentgenogram. Note the endotracheal tube and the respirator supply line.

about one-half of its original depth, both phrenic nerves should be stimulated alternately. All that needs to be done is to move the antenna from one receiver and place it over the second receiver on the other side of the chest. In quadriplegic patients, instead of the usual 9 volt battery, the transmitter can be plugged into a wall socket. Usually the inspiratory volume control is set so that the patient breathes 17 times per minute.

### ROENTGEN MANIFESTATIONS

It is good practice to obtain a roentgenogram after implantation of a stimulator. This will produce a record of the position of the stimulator and become a base line for further evaluation.

All 3 radio-frequency electronic stimulators are seen on a chest roentgenogram. The phrenic nerve and dorsal column stimulators show the entire implanted segment, the carotid sinus nerve stimulator shows only the connecting electrodes and the receiver. The electrodes placed at the carotid sinus must be evaluated by neck roentgenograms.

Certain stimulator malfunctions can be detected roentgenographically. A broken or detached lead at the receiver or electrode head can be identified. An electrode avulsion from the site of insertion can be suspected if the lead is too short. The avulsion can be minimal and detected only by noting a simple rotation of the electrode head. The "E" shaped electrode head of the dorsal column stimulator (Fig. 2) always points vertically.

The antenna, although placed externally, can be on the patient's skin during filming. This will be seen as an opaque coil (Fig. 3A) which will obscure the receiver and its connection to the electrode. If malfunction is suspected, a broken or disconnected wire should be sought with the antenna removed.

### SUMMARY

Three types of implanted electronic stimulators are discussed and illustrated to familiarize radiologists with indications, mode of implantations, functions and roentgenographic appearances.

Currently used are the: Dorsal Column Stimulator; Carotid Sinus Nerve Stimulator; and Phrenic Nerve Stimulator.

They are triggered by nonimplanted radio-frequency transmitters and 9 volt batteries, which can easily be changed as needed.

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### BONE AND SOFT TISSUE ABNORMALITIES OF THE UPPER EXTREMITY IN DIABETES MELLITUS\*

By WILLIAM L. CAMPBELL, M.D., and FRIEDA FELDMAN, M.D. NEW YORK, NEW YORK

IT is now widely recognized that diabetes mellitus may be complicated by skeletal lesions, so-called diabetic osteopathy. Roentgenographic abnormalities have included varying combinations of osteoporosis, juxta-articular cortical defects, bone resorption, sclerosis, fragmentation, and periosteal new bone formation. To date, diabetic osteopathy has been described predominantly in the metatarsals, phalanges and tarsals of the lower extremities.<sup>3,8,11</sup> In addition, Charcot-type changes may occur in joints of the proximal foot, ankle and knee; the spine is a rarer site of involvement.<sup>6,13</sup>

There have, however, been few well documented cases of roentgen abnormalities of the upper extremities in diabetes. Berenyi et al.1 published a case report of a diabetic with peripheral neuropathy who had a Charcot-type arthropathy of the wrist. They subsequently reported 6 diabetics with a purely atrophic resorptive arthropathy without hypertrophic bone changes. These patients all had peripheral neuropathy; the upper extremities were more frequently involved than the lower.12 Another diabetic patient with multiple neuropathic joints, including a wrist, was recorded by M. J. Feldman et al.7 A leading textbook of skeletal radiology illustrates diabetics with resorption of terminal phalangeal tufts, arterial calcification and osteoporosis in the hand, and hypertrophic arthropathy with periarticular soft tissue debris in a shoulder. However, the latter patient also had syringomyelia, a condition which is known to be associated with similar shoulder changes.9 Other scattered cases have received brief mention in the literature. Often these patients have had underlying diseases in addition to their diabetes that could account for the described roentgen changes.

The purpose of this article is to present examples of upper extremity skeletal and soft tissue abnormalities in diabetics and to describe their roentgenographic features. A roentgenographic survey of the hands, shoulders, and feet of 100 diabetics and 100 nondiabetics was also undertaken. The aim of this survey was to determine if minor and asymptomatic bone and soft tissue abnormalities were more common in the upper extremities of diabetics than in the nondiabetic population.

### MATERIAL AND METHOD

Nine diabetics with roentgenographic abnormalities of the upper extremities were selected to form the basis of this report. In addition, a roentgen survey of the hands, shoulders, and feet of 100 diabetic subjects was instituted. These were selected from patients attending a clinic for the treatment of diabetes at Columbia-Presbyterian Medical Center. The severity of their disease varied, but patients having long-standing disease with peripheral neuropathy were favored for inclusion in the study on the premise that they would be most likely to exhibit upper extremity abnormalities. Control subjects consisted of 100 nondiabetics referred for skeletal survey for a variety of indications. Roentgenograms of hands, shoulders, and feet were taken of both groups. All roentgenograms were analyzed, and abnormaliincluding deossification, ties, changes, cortical erosions, productive

<sup>\*</sup> From the Department of Radiology, College of Physicians and Surgeons, Columbia University, Columbia-Presbyterian Medical Center, New York, New York.

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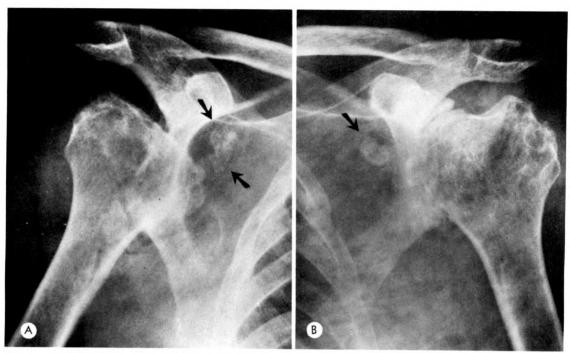


Fig. 1. Anteroposterior views of (A) right and (B) left shoulders. Sixty-seven year old male with known diabetes for 8 years. There are evidence of bilateral joint space narrowing, productive changes, and marked humeral head deformity. The abruptly flattened appearance of the right humeral head, as if "amputated by an axe," is a characteristic hallmark of the Charcot-type joint. Note the relative scarcity of osseous fragments due to resorption; only a few remain (arrows). Note the cystic changes in the left humeral head, as well as apposing glenohumeral subchondral sclerosis.

changes, and soft tissue and vascular calcification, were tabulated.

### ROENTGEN FEATURES

Marked shoulder osteoarthropathy was characterized by glenohumeral joint space narrowing, humeral head deformity with evidence of bone resorption, varying degrees of subchondral sclerosis, cystic changes, and subluxation (Fig. 1; 2; and 3). Bone fragments may be seen in the periarticular soft tissues, but were not extensive in our experience (Fig. 1). Trauma to the shoulder may further accentuate the existing abnormality (Fig. 2A). Resorption of fragments may occasionally occur.

In less advanced cases, actual bone resorption may not be seen. In these patients, cystic and sclerotic changes occurred in the humeral head, glenoid and acromion. Roughened cortical contours, subluxation and mild varus deformity

with flattening of the humeral head medially were also noted (Fig. 3; and 4). One patient exhibited bilateral shoulder chondrocalcinosis (Fig. 5), while another patient, an acromegalic, had a "crescent sign" indicative of a subchondral fracture of the humeral head (Fig. 4).

In addition, classical roentgenographic changes indicative of a neurotrophic joint may be seen in the elbow (Fig. 6) and wrist.<sup>1,7</sup> The severe joint destruction, sclerosis, and extensive periarticular bone fragments resemble the better known diabetic neurotrophic joint of the proximal foot, ankle, and knee.

In the hands, roentgenographic changes are, in our experience, less striking. Vascular calcification is more common in diabetics (Fig. 7). Periarticular cortical erosions of the interphalangeal and metacarpophalangeal joints may be noted (Fig. 8). One patient with severe peripheral neuropathy

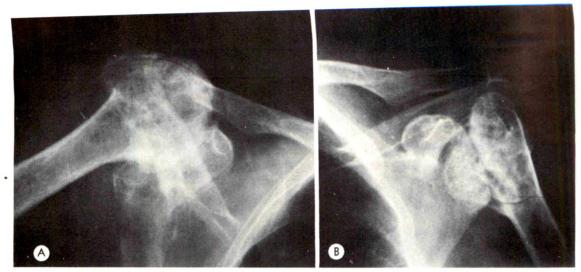


Fig. 2. Anteroposterior views of (A) right and (B) left shoulders. Seventy-nine year old female with diabetes for 19 years. (A) There is cephalad subluxation associated with subchondral sclerosis and cystic change of the humeral head and glenoid. (B) The left humeral head is deformed, partially resorbed, and posteriorly dislocated. A pseudoarthrosis has resulted in sclerosis of the contiguous surfaces. A recently sustained fracture has further accentuated the deformity.

developed bilateral "claw-hand" deformities with flexion contractures of the proximal interphalangeal joints. Deossification was present, but could have been secondary to disuse.

### REPORT OF A CASE

J.C., a 67 year old male photographer with a 5 year history of diabetes mellitus, was seen at another hospital on May 27, 1967, complaining of low back pain that radiated into the right

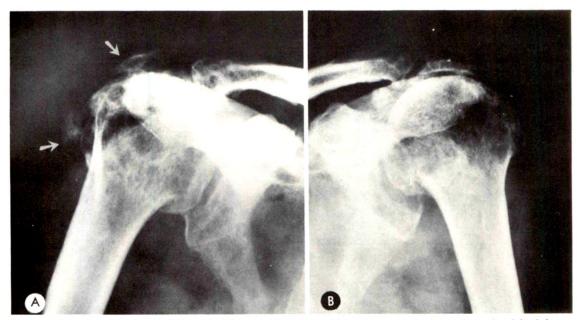


Fig. 3. Anteroposterior views of the (A) right and (B) left shoulders. Seventy-nine year old male with diabetes of 7 years' duration. There was clinical evidence of peripheral neuropathy in both lower and upper extremities. There are bilateral cystic and sclerotic changes of the humeral heads. "Cysts" are also present in the acromion processes and the distal clavicles. In A, an underpenetrated view, bone fragments are demonstrated in the soft tissues (arrows).

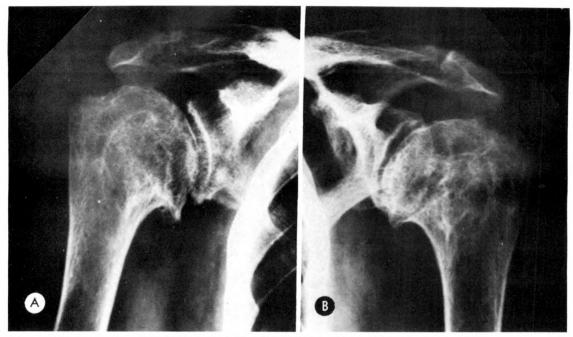


Fig. 4. Anteroposterior views of the (A) right and (B) left shoulders. Sixty-three year old acromegalic male with 14 year history of diabetes mellitus and electromyographic evidence of peripheral neuropathy in the upper and lower extremities. Note the misshapen large humeral heads and widened joint spaces compatible with acromegaly. However, the cystic and productive changes have been aggravated by the superimposed neuropathy. Note the subchondral linear radiolucency paralleling the articular surface of the right humeral head. This "crescent sign" was interpreted as a subchondral fracture. A similar, but less pronounced, change was present on the left.

lower extremity. He had previously undergone surgical amputations of 2 toes of the right foot for osteomyelitis. On skeletal survey there were marked narrowing and productive changes at the L4-5 level interpreted as severe degenerative disease. Myelography revealed cervical spondylosis and thecal defects at the L4-5 level related to spondylolisthesis. Destructive changes involving both shoulder joints were considered by the radiologist to be suggestive of neuropathic disease. Other diagnoses entertained clinically such as rheumatoid arthritis, ankylosing spondylitis and neurosyphilis were not substantiated. The final impression was that of impairment of the central and peripheral nervous system on the basis of diabetes. He was treated with bed rest, progressive locomotion, and a brace and discharged on July 8, 1967.

On April 7, 1970, he was admitted to the Columbia-Presbyterian Medical Center, complaining of urinary incontinence, a right foot drop, and progressive low back pain radiating down the right leg. Neurologic examination revealed muscular atrophy and diminished reflexes in both the upper and lower extremities. Diminished position sense and decreased vibration sense were noted predominantly in the lower extremities. The cranial nerves were intact, save for Argyll-Robertson pupils.

Electromyography revealed generalized denervation in the proximal and distal muscles particularly involving the right arm and leg. The examination was consistent with a chronic

Fig. 6. (A) Lateral and (B) oblique views of the right elbow. Fifty-nine year old diabetic female. There is marked disorganization of the elbow joint, with destruction of articular surfaces. Note the numerous bone fragments and periosteal new bone formation. The latter finding occasionally mimics osteomyelitis, but may be explained by repeated trauma to a hypesthetic joint. (Courtesy of Dr. Rubem Pochaczevsky.)

diffuse polyneuropathy in which the distal muscles were more affected than the proximal ones. Serology, including cerebrospinal fluid colloidal gold, Kolmer, VDRL, and FTA absorption tests were negative. A cystometrogram was suggestive, but not completely diagnostic, of neurogenic dysfunction.

Roentgenograms of the cervical and lumbar spine revealed pronounced narrowing and osteophyte formation at the C5-6 and C6-7 levels with adjacent vertebral body sclerosis. A marked spondylolisthesis at the L4-5 level was associated with complete obliteration of the disk space as well as sclerotic and destructive changes in adjacent vertebral bodies. A myelogram showed partial obstruction at the C6-7 interspace, with a large ventral defect attributed to a herniated nucleus pulposus. A complete block above the L4-5 interspace was secondary to spondylolisthesis. Shoulder roentgenograms showed marked deformity of both humeral heads with narrowed joint spaces and productive changes. Calcific and bony debris were noted in the soft tissues about both joints (Fig. 1).

It was felt that the patient had a distal and peripheral neuropathy secondary to diabetes



Fig. 5. Anteroposterior view of the left shoulder. Fifty-six year old female with diabetes of 30 years' duration. Note florid chondrocalcinosis, which was bilateral. Blood chemistries, including calcium, phosphorus, uric acid, and alkaline phosphatase, were normal.

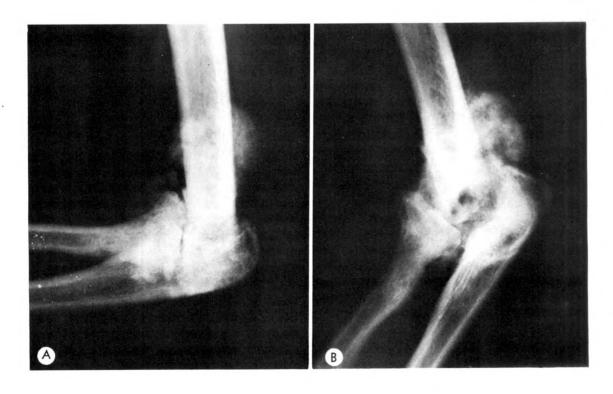




Fig. 7. (A and B) Lateral views of both wrists in a 73 year old female with maturity onset diabetes. Note the heavily calcified arteries bilaterally.

mellitus. The Argyll-Robertson pupils were also felt to be related to diabetes in view of his continued negative serum and spinal fluid serology. After further assessment, and in view of a chronic cardiac condition, it was felt that operative intervention would not substantially benefit the patient. A brace was again recommended, and he was discharged on April 29, 1970, on tolbutamide to be followed in the clinic.

### SURVEY OF IOO DIABETIC AND IOO NONDIABETIC PATIENTS

Roentgenograms of hands, shoulders, and feet in 100 diabetics were analyzed and compared to 100 nondiabetic controls. The average age of the diabetic population was 60.4 years, the nondiabetic population 63.7 years. Duration of diabetes ranged

from <1 year to 48 years with an average of 14.2 years. Fifty-seven diabetics were being treated with insulin, 35 by oral hypoglycemic agents; 8 were being treated by diet alone or were receiving no specific therapy.

Subchondral and periarticular cystic bone changes were twice as frequent in diabetics as in nondiabetics (Table 1). These cystic changes were of the type frequently seen in older people and generally considered to be "degenerative" in nature. They varied in severity from minimal to marked but tended to be more obvious in diabetics than in the control group. They occurred at an earlier age in diabetics and became more numerous and more pronounced with age in both diabetics and



Fig. 8. (A) Posteroanterior and (B) oblique views of the hand in a 54 year old female with diabetes for 11 years. Note the periarticular cortical erosions best seen about the proximal interphalangeal joints of the second, third, and fourth fingers of the left hand (arrows).

controls. Although the changes in diabetics for a given age group tended to be more severe than in nondiabetics, we could detect no qualitative differences between the cystic lesions of the 2 groups. The incidence was similar in males and females.

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Small cortical bone erosions, usually juxta-articular, were uncommon and generally inconspicuous. They were noted in 6 per cent of diabetics and 2 per cent of controls. Actual bone resorption was seen in 2 diabetics, and involved the feet (phalanges and metatarsal heads) in both cases.

Nonvascular soft tissue calcification was

TABLE I
INCIDENCE OF CYSTIC BONE CHANGES

	100 Diabetics (per cent)	100 Nondiabetics (per cent)
Hands	32	8
Shoulders	43	29
Feet	14	6

more common in diabetics than in the controls (Table II). For the most part, this had the characteristic roentgenographic appearance of calcific tendinitis, particularly about the shoulders. Sometimes, small calcific flecks within soft tissues in the vicinity of joints, particularly in the hands and feet, were present. These, too, most likely represented calcific tendinitis.

Vascular calcification has previously been noted to be increased in diabetics; this was confirmed in our study (Table III). Calcification was more frequently ap-

TABLE II

INCIDENCE OF NONVASCULAR SOFT
TISSUE CALCIFICATION

	1∞ Diabetics (per cent)	100 Nondiabetics (per cent)
Hands	15	3
Shoulders	32	12
Feet	4	5

		TABLE III	Į.
INCIDENCE	OF	VASCULAR	CALCIFICATION

	100 Diabetics (per cent)	100 Nondiabetics (per cent)
Hands	8	I
Shoulders	0	I
Feet	25	11

preciated in the feet and ankles than in the hands and wrists.

Joint space narrowing, usually involving the interphalangeal joints of the hands, was noted in 5 per cent of diabetics and I per cent of nondiabetics. Articular subluxations were present in 5 per cent and 4 per cent of diabetics and nondiabetics, respectively. There were no differences in the incidence of deossification or productive changes between diabetics and the control group.

Thirty-three of the 100 diabetics had definite (24 cases) or probable (9 cases) peripheral neuropathy. In 8 cases, there was specific evidence of neuropathy in the upper extremities; all cases had lower extremity neuropathy. The incidence of bone erosions and cystic changes was no different in diabetics with neuropathy than in those without neuropathy. Neuropathy was present in the 2 patients with bone resorption.

### DISCUSSION

Although there are few prior reports of upper extremity diabetic osteoarthropathy, the occurrence of such bone changes in the upper limbs should not be unexpected. The conditions that have been suggested as predisposing to osteoarthropathy in the legs and feet are peripheral neuropathy, trauma, and possibly underlying abnormal bone. These same conditions are present, albeit perhaps to a lesser degree, in the upper extremities. Although diabetic neuropathy is characteristically most apparent in the lower extremities, it is probably more common in the upper

extremities than is generally appreciated. Ellenberg,5 in a survey of 200 ambulatory out-patient diabetics, noted an incidence of lower limb impairment of 73 per cent, but found 54 in the same group with upper extremity neuropathy, an incidence of 27 per cent. Indeed, the incidence of neuropathy in diabetics may largely depend on the diligence of the examiner and the sophistication of the techniques applied toward detection. Thus, Chochinov et al.2 have determined that patients with juvenileonset diabetes have very early impairment of sensory perception in the upper as well as in the lower extremities. In this connection, our 33 per cent incidence of definite or probable diabetic neuropathy was based on an often limited neurologic examination, and is almost certainly too low.

The incidence of major upper limb osteoarthropathy (bone resorption, major joint destruction, Charcot joint) is undoubtedly low; we found none in our survey of 100 diabetics. Minor bone changes, calcific tendenitis, and vascular calcification, on the other hand, are relatively common (Tables 1–111).

In the feet, Pogonowska et al.<sup>11</sup> found osteopathy in 7 per cent and vascular calcification in 20 per cent of 242 diabetics. These numbers are similar to our data showing 2 per cent with bone resorption, 3 per cent with cortical erosion, 14 per cent with cystic changes, and 25 per cent with vascular calcification.

Unlike Pogonowska et al., we did not find an increased incidence of osteoporosis (deossification) as compared to our non-diabetic controls. In assessing the roent-genograms, we distinguished between deossification (a relatively homogeneous loss of bone density which might be localized or widespread) and cystic changes (relatively well defined round areas of decreased bone density with a definite border, occasionally appearing "punched out," which could be single or multiple). It is possible that some of the abnormalities characterized as "osteoporosis" by Pogonowska et al. and those described in our

cases as "cystic changes" actually represent the same processes. It is tempting to speculate that these changes in the subchondral bone may predispose a joint to more marked osteoarthropathy. However, we personally have seen no instances of progression of minor cystic changes to advanced osteoarthropathy, nor could we correlate cystic changes with the presence of peripheral neuropathy. Neuropathy was associated with 2 cases of bone resorption in the feet.

Periarticular soft tissue calcification was increased in diabetics (Table 11). Typically, this was calcific tendinitis, although rarely the possibility of a residual small bone fragment related to previous trauma could not be excluded. In any event, calcific tendinitis in the shoulder and hand was more frequent in our diabetic population. This is in keeping with the observation by Podolsky<sup>10</sup> that, based on clinical impressions at the Ioslin Clinic, shoulder bursitis and periarthritis are more common in diabetics than nondiabetics. Dobson,4 in unpublished material, found that 30 per cent of 89 diabetics had a history of bursitis sometime in the past. Only 15 per cent of a smaller nondiabetic control group had a similar past history. These figures are quite similar to our data shown in Table 11.

Vascular calcification has long been recognized as a frequent roentgenographic finding in diabetics (Fig. 7). We found arterial calcification in the hand and/or wrist in 8 per cent of diabetics and in only 1 per cent of nondiabetics. Our incidence of 25 per cent vascular calcification in the feet is similar to previously published figures.<sup>11</sup>

It has been suggested that symptomatic osteoarthritis is more common in diabetics than in nondiabetics (Waine, H. et al., cited by Podolsky). Podolsky<sup>10</sup> has proposed an hypothesis that might account for increased osteoarthritis in diabetics on the basis of a combination of abnormal stress on cartilage and decreased levels of polysaccharide in the cartilage matrix. We did

not find roentgenographic evidence of increased productive degenerative changes in diabetics, although more diabetics than nondiabetics did have joint space narrowing (5 per cent *versus* I per cent). As has been noted previously, cystic changes in the ends of bones, often subchondral, were more numerous in the diabetic population.

### CONCLUSION AND SUMMARY

Roentgenographic evidence of bone and soft tissue abnormalities may be noted in the upper extremities of diabetics.

Major shoulder changes, typically associated with peripheral neuropathy, include humeral head deformity due to bone resorption, joint space narrowing, subchondral cysts and sclerosis, subluxation, and juxta-articular soft tissue bone fragments. Charcot-type joints, characterized by severe joint destruction, sclerosis, multiple bone fragments, and soft tissue swelling may occur. Diabetic neuropathy can produce flexion contractures of the hand.

Abnormalities not necessarily associated with clinical neuropathy include cystic bone changes, cortical bone erosions, soft tissue calcification (calcific tendinitis), and vascular calcification.

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### NEUROGENIC DISORDERS OF THE FOOT IN DIABETES MELLITUS\*

By ERNEST KRAFT, M.D., EFTHIMIOS SPYROPOULOS, M.D., and NATHANIEL FINBY, M.D.

NEW YORK, NEW YORK

DIABETIC neuropathy of the foot has been found more frequently in recent years. This observation can be linked to the longevity of diabetic patients and the dramatic decrease of infant mortality since the insulin era. It is estimated that one-half of the adult diabetic population owes its survival to proper care since childhood.

The actual increase of cases has been confirmed at the St. Luke's Hospital Center and the Veterans Administration Hospital, Outpatient Clinic, and it has been found that specific bone changes can be easily identified roentgenologically.

### ROENTGEN FINDINGS

Two types of bone changes can be distinguished: (1) the Charcot joint (destructive type); and (2) bone absorption (mutilating type).<sup>3, 9, 11</sup> The former affects tarsal bones, while the latter is confined to the forefoot. Both types may develop concurrently and even bilaterally but not in symmetric fashion.

The Charcot joint (destructive type) is caused by repeated trivial injuries<sup>4</sup> and merely by walking. These lesions tend to remain unrecognized due to the absence of pain. Therefore, bone and joint changes are usually far advanced when first recognized.

Initially, a relaxation of joint capsules leads to a talipes valgus and an instability of intertarsal and tarsometatarsal joints. A lack of proprioceptive reflexes allows constant grinding and shearing motions which result in fragmentation and infraction of tarsal bones (Fig. 1; and 2).

As the relaxation increases and trau-



Fig. 1. Precursor of a diabetic foot. Infraction of medial cuneiform bone (arrow). In the absence of trauma, a search for an underlying diabetes is indicated.

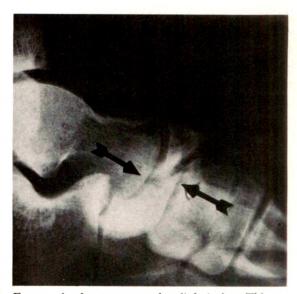


Fig. 2. Another precursor of a diabetic foot. This 34 year old diabetic man suffered an unsuspected fragmentation of a navicular bone (arrows).

From the Radiology Services of the St. Luke's Hospital Center and the Veterans Administration Hospital, Outpatient Clinic, New York, New York.

<sup>\*</sup> Presented as an Exhibit at the Seventy-fifth Annual Meeting of the American Roentgen Ray Society, San Francisco, California, September 24–27, 1974.

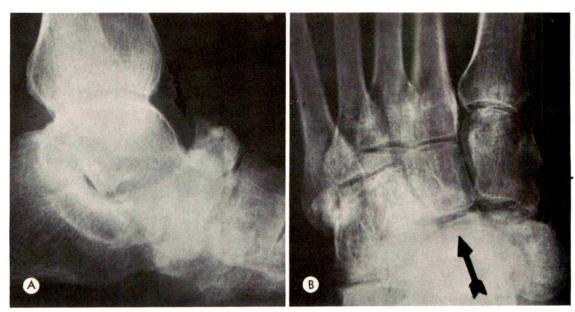


Fig. 3. (A) Lateral view shows marked dorsal dislocation of the medial fragment of the navicular bone (arrow). (B) Anteroposterior view of the same foot illustrates marked thinning, spreading, and sclerosis of the lateral fragment of the navicular bone (arrow).

matic events accumulate, dislocations combined with fractures occur. Figure 3 illustrates a marked dorsal dislocation of the medial fragment of a navicular bone in a diabetic man. In the anteroposterior pro-

jection, spreading, flattening, and sclerosis of the lateral fragment are noted (Fig. 3B).

Bone destruction progresses rapidly. Figure 4A shows normal tarsal bones, while 4 months later advanced destruction





Fig. 4. (A) Rapid development of bone destruction. The tarsal bones are normal. Note stump of fifth metatarsal bone from preceding resection. (B) Same foot 4 months later. Marked destruction of tarsal and metatarsal bones with dorsal dislocation of the cuneiform bones and of the first metatarsal base. Recent fracture of the fourth metatarsal shaft. Rounding of fifth metatarsal stump.

and disintegration of these bones become evident (Fig. 4B). Another diabetic patient presented merely with a swollen ankle without bone changes (Fig. 5A). Eight months later the same clinical impression prevailed, but a far advanced destruction of tarsal bones could be demonstrated on roentgenograms of the still swollen ankle (Fig. 5B). The diseased foot had remained clinically unremarkable.

As a result of progressive valgus deformities, tarsal bones deviate and bulge medially, and the cuboid bone shifts away from the fifth metatarsal base (Fig. 6). Significant roentgen findings include erosion, sequestration, and osteolysis (Fig. 7, A





Fig. 5. (A) This 47 year old diabetic patient presented with only a swollen ankle. The tarsal bones were unremarkable. (B) Same foot 8 months later. The ankle was still swollen and the foot clinically unremarkable. Far advanced destruction of tarsal bones now evident on roentgenograms of the ankle.

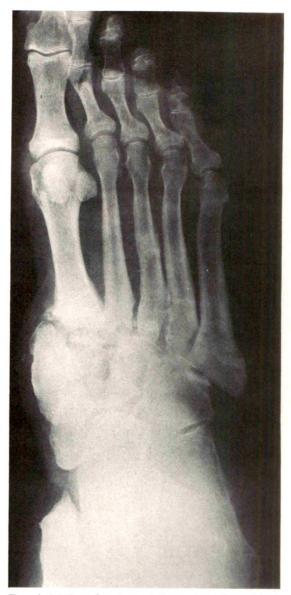


Fig. 6. Moderately advanced destruction of cuneiform bones and metatarsal bases. Progressive valgus deformity. Tarsal bones deviate and bulge medially, so that the cuboid bone is shifted away from the fifth metatarsal base.

and B).<sup>1,9</sup> Metatarsal fragments may remain ununited, especially when a superimposed infection develops. A healing tendency follows prolonged immobilization as seen in Figure 8, A and B, which was obtained 11 months apart. Even in far advanced cases, bones may regenerate, thereby exhibiting hyperostosis, periosteal calcification, callus, and synostoses (Fig. 9).<sup>3</sup>

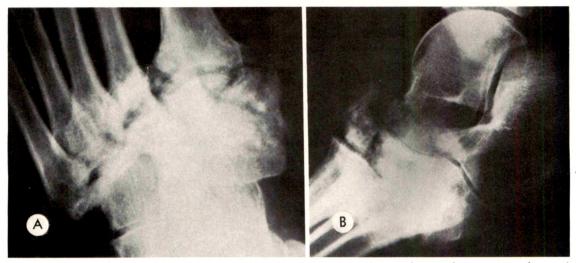


Fig. 7. (A) Far advanced destruction of tarsal bones with valgus deformity, surface erosion, sequestration, and osteolysis in a 37 year old diabetic patient. (B) Lateral view of the same patient illustrates dorsal dislocation of grossly sequestered cuneiform bones and a vertical talus.

Secondary osteoarthritis can also develop with spur formations (Fig. 10, A and B).

Bone absorption (mutilating type) affects metatarsal heads and toe phalanges. The epiphyseal ends gradually vanish, while the shafts taper with pencil-point

narrowing (Fig. 11). Bones tend to become sclerotic, thereby simulating an osteomyelitis.

At times, the bases of proximal phalanges broaden and form a cup shape. Varieties of resulting deformities are known as: (1) in-

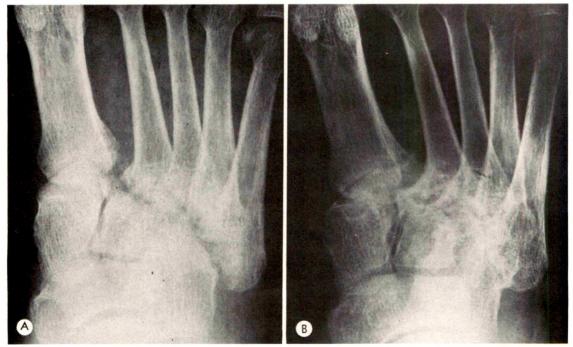


Fig. 8. (A) A milder case of bone destruction of metatarsal bases and of contiguous cuneiform bones II and III with a healing tendency. (B) Same foot with healing II months later. A synostosis is now evident in the tarsometatarsal joints.

trusion; (2) mortar-in-pestle; (3) pencil-in-cup; and (4) balancing pagoda. <sup>16</sup> Synostoses of tarsometatarsal and intertarsal joints may accompany this process of bone absorption (Fig. 12).

In far advanced stages, proximal phalanges are absorbed. The involved toes become foreshortened but remain painless in spite of a telescoping effect. Thick plantar callosities frequently accompany the disease process and may result in dislocations (Fig. 11).

There usually is dorsiflexion of toes and a talipes cavus, in contrast to the valgus deformity in the Charcot type. Osteomyelitis is frequently suspected when sequestered necrotic bones extrude through a neuropathic ulcer or *mal perforant*. However, an associated infectious bone lesion is usually absent.

### VASCULAR CHANGES

Vascular calcifications are encountered in the majority of cases (Fig. 11) without necessarily causing signs of occlusion. Specific angiographic findings include: (1) arterial stenosis; (2) decreased perfusion; and (3) diminished flow through small arterial branches.<sup>6</sup>

### MATERIAL

The material comprises 22 patients with diabetes mellitus, 2 with sciatic nerve lesions, and 2 with an unknown etiology. Their age ranged from 29 to 72 years with an average of 55. The sexes were evenly divided.

The Charcot type was encountered in 11 patients, bone absorption in 12, and a combination of both types in 3. Bilateral involvement was present in 2 patients, with bone absorption of both feet in one. The second patient presented with bone absorption in one foot and a Charcot joint in the other. Vascular calcifications were observed in 13 patients (50 per cent).

### PATHOGENESIS

Both types of foot lesions can be traced to neurologic deficits. In the Charcot type,

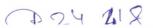


Fig. 9. More advanced destruction with healing. Note periosteal callus and fusion of the second and third tarsometatarsal joints.

a degeneration of the posterior column of the spinal cord takes place, as in tabes dorsalis. In bone absorption, a peripheral neuropathy affects the postganglionic segments of the spinal nerves, also sympathetic, sensory, and motor fibers. <sup>16</sup> Recently, an avascular necrosis has also been suggested as an etiologic factor.<sup>2</sup>

### DIFFERENTIAL DIAGNOSIS

The differential diagnosis of the *Charcot type* includes osteomyelitis and tuberculosis. In these conditions, fistulae are fre-



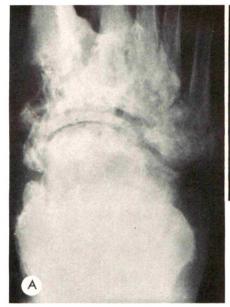




Fig. 10. (A) Healing after advanced destruction and fragmentation involving also the flattened navicular bone and spur formations. (B) Same case. Lateral view illustrates osteoarthritis secondary to healed advanced destructive process.



FIG. 11. Bone absorption (mutilating type). Penciling of the proximal interphalangeal joint of the second toe with subluxation (arrow). Dislocation of the first metatarsophalangeal joint due to an underlying callosity. Marked vascular calcifications.

quently encountered and clinical manifestations predominate, in contrast to their absence in the Charcot type.

In tabes dorsalis, roentgen findings of "bags-of-bones" are essentially identical with those in diabetic neuropathy. A tabetic foot, however, can be excluded because specific lesions in tabes usually occur only in larger joints and in the spine<sup>9</sup> and practically never in the foot. Even in the ankle joint, diabetic neuropathy is more likely to develop than a tabetic lesion (Fig. 13).<sup>12</sup> A combination with bone absorption in the forefoot, when present, can readily clarify the diagnosis of a diabetic condition.<sup>15</sup>

Bone absorption (mutilating type) by itself cannot be distinguished from other neuropathic disorders such as sciatic nerve lesions, leprosy, alcoholic neuritis, 4,17 syringomyelia, burns, frostbite, neurologic deficit, psoriasis, scleroderma, familial osteolysis, arthritis mutilans, 11 and infected callus. However, a combination with destructive changes of tarsal bones appears characteristic of diabetes mellitus (Fig. 14).8

### DISCUSSION

In the Charcot type, tendon reflexes are practically absent. There are zones of

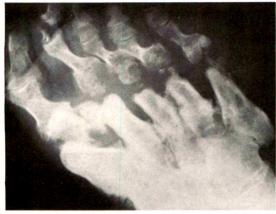


FIG. 12. Bone absorption (mutilating type). Ununited fractures of all metatarsal bones. Tapering of the fifth metatarsal shaft. Mortar-in-pestle configuration of metatarsophalangeal joints II-v. Synostosis of intertarsal and tarsometatarsal joints.

paresthesia, anesthesia, diminished vibration, and lack of pinprick sensation. An absence of position orientation and of protective pain leads to overburdening of tarsal joints and to destructive changes.

In the bone absorption or mutilating type, a peripheral neuropathy may simulate the effects of a sympathectomy. A

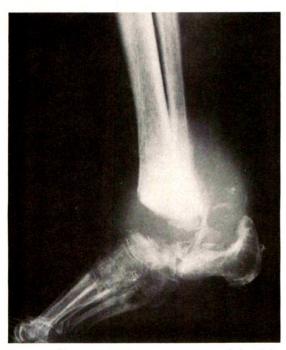


Fig. 13. Charcot-type bone destruction of the right ankle in a woman with severe complications of diabetes mellitus.

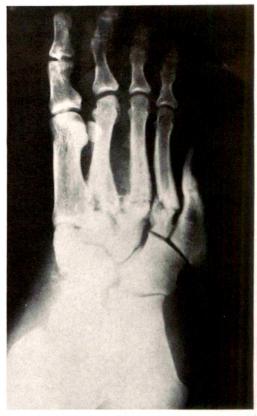


Fig. 14. Combination of bone absorption of the fifth metatarsal bone with bone destruction of tarsal bones is considered characteristic of a neurogenic disorder of the foot in diabetes mellitus.

dysregulation is believed to cause vasodilatation, hyperemia, and osteolysis.<sup>11</sup>

The patients usually present with a severe chronic diabetes mellitus which has become resistant to management or has been grossly neglected. Occasionally, however, the disease remains mild, of short duration, and even unrecognized. Thus, specific roentgen changes of the foot can serve as clues to the detection of the diabetes. \*

According to Ellenberg,<sup>6</sup> diabetic osteopathy may even precede an overt diabetes. In such an instance, the underlying metabolic disorder can also be confirmed by other associated findings such as nephropathy, retinopathy, myelopathy, specific skin lesions, peripheral neuritis, and diseases of the cardiovascular system, the gastrointestinal tract, and the endocrine system.<sup>5</sup>

An almost exclusive localization of the osteopathy in the foot represents an outstanding feature of the diabetic neuropathy. The ankle is less frequently affected (Fig. 13), while involvement of other parts of the skeleton is exceptional and merely confined to single case reports.7

### SUMMARY

Neurogenic disorders of the foot in diabetics have been found with increasing frequency in recent years. Therefore, familiarity with the spectrum of roentgen findings appears essential.

Significant changes include Charcot joints of the tarsus (destructive type), and bone absorption of the forefoot (multilat-

ing type).

Charcot joints have been observed in 11 patients, bone absorption in 12, and a combination of both types in 3. This combination strongly suggests a diabetic neuropathy.

Pathogenesis and differential diagnosis

are briefly discussed.

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### THE NAVICULAR FAT STRIPE\*

### A USEFUL ROENTGEN FEATURE FOR EVALUATING WRIST TRAUMA

By DANIEL W. TERRY, Jr., M.D., and JAMES E. RAMIN, M.D.†

IN some circumstances, routine roentgenograms do not directly demonstrate a fracture, yet a fracture is suspected due to displacement or obliteration of fatty tissue normally located adjacent to the bone in question. The term "fat pad" or "fat stripe" has been applied to such collections of fat, and "positive fat pad sign" to abnormal displacement.

The purpose of this report is to draw attention to the navicular fat stripe (NFS), a valuable roentgen feature when interpreting wrist roentgenograms obtained following trauma.

### NAVICULAR FAT STRIPE ANATOMY

The navicular fat stripe (NFS) is a small triangular or linear collection of fat located between the radial collateral ligament and the synovial tendon sheaths of the abductor pollicis longus and the extensor pollicis brevis (Fig. 1). The radial collateral ligament extends between the tip of the radial styloid and the lateral aspect of the navicular bone, t with some fibers attaching to the base of the greater multangulum. The abductor pollicis longus and extensor pollicis brevis originate from the dorsal surface of the forearm and insert on the base of the first metacarpus and first proximal phalanx, respectively. On adult wrist roentgenograms, the NFS is seen on posteroanterior and anterior oblique views as a thin radiolucent line paralleling the lateral surface of the naviculum (Fig. 2, A and B). The NFS is not con-

Fig. 1. Anatomic relationships of navicular fat stripe (NFS). The NFS (shaded black) is located between the combined tendon sheaths of the abductor pollicis longus and extensor pollicis brevis, and the lateral surface of the naviculum.

sistently identifiable in children less than 11 or 12 years of age.

### MATERIAL AND METHOD

During the 12 month period from January through December 1973, 438 wrist roentgenograms of patients over 12 years of age were obtained at the emergency

EXTENSOR
POLLICIS
BREVIS
NFS

RADIAL
COLLATERAL
LIGAMENT
ABDUCTOR
POLLICIS
LONGUS

<sup>‡</sup> Although the Nomina Anatomica lists Os scaphoideum as the name for this bone, naviculum enjoys more popular usage.

<sup>\*</sup> Presented at the Seventy-fifth Annual Meeting of the American Roentgen Ray Society, San Francisco, California, September

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Fig. 2. (A) Roentgenogram and (B) line drawing of a normal wrist. In A the NFS is indicated by arrows. In B the NFS is shaded.

X-ray Department of Milwaukee County General Hospital for the evaluation of trauma. Generally, a direct exposure nonscreen technique was used (100 mas. and 50-54 kvp.). A high speed screen technique (2.5 mas. and 50-54 kvp.) was used for bandaged wrists or uncooperative patients. The film used for both techniques was DuPont Cronex 4 screen film. We selected for review standard wrist and hand series, each of which included posteroanterior, anterior oblique, and lateral views. This method excluded most distal radial shaft fractures because the distal forearm is examined in our emergency room by obtaining only posteroanterior and lateral projections. A spot review, however, was done on 30 distal radius fractures examined roentgenographically during the same 12 month interval.

### RESULTS

A well visualized, nondisplaced NFS was demonstrated on 386 of 400 (96 per cent) wrist roentgenograms taken on subjects in whom wrist injury was not substantiated. Fourteen normal wrists did not have a roentgenographically demonstrable fat stripe. The roentgenograms on 2 of 5 patients with traumatic generalized soft tissue swelling of the hand without underlying fracture demonstrated absence of the

TABLE I

ROENTGEN APPEARANCE OF THE NAVICULAR FAT STRIPE IN VARIOUS CONDITIONS

Condition	Normal	Absent	Displaced	Number
Normal	386	14	0	400
Navicular Fracture	2	9	4	15
Radial Styloid Fracture	0	8	2	10
First Metacarpal Fracture	2	4	I	7
Greater Multangular Fracture	0	ī	0	Í
Soft Tissue Swelling	3	2	0	5
Total				438
Distal Radial Fracture	25	5	0	30

navicular fat stripe. Four per cent of the wrist roentgenograms thus demonstrated a false positive NFS sign. The NFS was either absent or displaced in 29 of 33 (88 per cent) wrist roentgenograms obtained on patients with fractures involving the bones on the radial side of the wrist. The types and numbers of fractures associated with a positive navicular fat stripe sign are shown in Table 1. The NFS was absent or displaced in 13 of 15 navicular fractures. All 10 radial styloid fractures, and 5 of 7 fractures involving the base of the first metacarpus, showed absence or displacement of the NFS.

Review of 30 distal radius fractures revealed that the NFS was normal in the presence of simple fracture (25 instances). Displacement of the NFS was noted in the 5 comminuted distal radial fractures which extended to the radial-navicular joint.

An example of a normal NFS is shown in Figure 2A. NFS displacement (positive NFS sign) may accompany a navicular fracture which is not evident on the initial roentgenograms (Fig. 3). In some instances, a time interval of about 1 hour following injury may be necessary for a positive NFS sign to develop (Fig. 4, A and B). Presumably, enough edema fluid or blood must accumulate to displace or obliterate

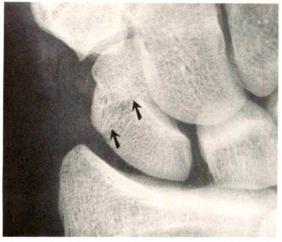


Fig. 3. Positive NFS sign. A navicular fracture (arrows) has caused obliteration of the navicular fat stripe.

the NFS. The NFS seems to return to normal in a variable period after the acute fracture has occurred. Fractures for which follow-up roentgenograms were available showed reappearance of the fat stripe within 5 days to 2 months of the initial trauma (Fig. 5). Presumably, the NFS would reappear as soon as the edema and hemorrhage subsided. A preserved NFS in the presence of navicular or other wrist bone abnormality would strongly suggest that no acute fracture is present.

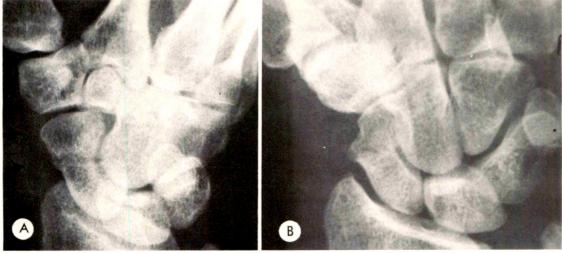


Fig. 4. Temporal profile of NFS disappearance with trauma.

(A) Roentgenogram taken  $\frac{1}{2}$  hour after wrist injury demonstrates a navicular fracture, but the NFS is intact (arrows). (B) A second roentgenogram taken I hour later reveals obliteration of the NFS.

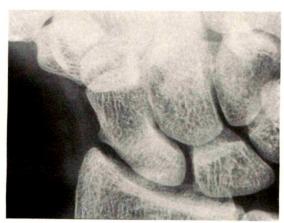


Fig. 5. Healing navicular fracture. A fracture through the waist of the naviculum demonstrates sclerosis associated with healing. The NFS is well visualized.

### DISCUSSION

The diagnostic significance of fatty tissue displacement secondary to local traumatic injury of underlying bones has already been described.1-4 Results of this present study indicate that the NFS is a useful feature for evaluating wrist roentgenograms for signs of bone injury. Navicular fractures are frequently difficult to diagnose on routine hand and wrist roentgenograms. In some instances, special views may demonstrate the fracture, but occasionally the fracture is missed and untreated or diagnosis is unduly delayed until a repeat examination is obtained after sufficient time has elapsed for resorption to occur at the fracture site. The NFS is almost always displaced or obliterated following trauma to the radial side of the wrist sufficient to fracture the naviculum. radial styloid process, or proximal first metacarpus. The presence of a positive NFS sign should alert the radiologist to the likelihood of an underlying wrist fracture.

Specifically, navicular fractures can be identified earlier if NFS abnormality is present on roentgenograms of a traumatized wrist.

### SUMMARY

The navicular fat stripe (NFS) is a useful roentgenographic feature for evaluating traumatic wrist injury.

A radiolucent stripe, cast by a thin collection of fat paralleling the lateral surface of the navicular bone, was seen in 96 per cent of 400 normal wrists examined because of trauma. Obliteration or displacement of this line (positive NFS sign) is commonly present in acute fractures of the naviculum, radial styloid process, and proximal first metacarpus.

A positive NFS sign serves to alert the radiologist that an underlying fracture is likely. In particular, the NFS sign generally accompanies a navicular fracture.

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### SOLITARY PHALANGEAL DEFECT IN THE HAND\*

### REPORT OF 2 RARE CASES

By KENNETH R. KATTAN, M.D., DIANE S. BABCOCK, M.D., and BENJAMIN FELSON, M.D.

A SLOWLY expanding defect in a phalanx of a finger is usually caused by a benign tumor, the most common of which is solitary enchondroma. Tumor arising in the soft tissues of a digit is a less common cause for a lytic bone lesion.

The 2 cases described here illustrate rare causes of such a lesion.

Case I. This 17 year old girl had lacerated her finger under a ring 3 months earlier. The ring was of the type which is open on one side. She could not remove the ring, but did not seek immediate medical assistance. The ring gradually eroded through the wound and became embedded in her proximal phalanx. She finally came to the emergency room where a roent-genogram of the finger (Fig. 1A) was obtained.

The ring was excentrally situated on the finger with the margins of the open end clamped through a bony defect. Another roentgenogram

taken after the ring was removed (Fig. 1B) demonstrated the bone defect with sharp sclerotic borders. There was thickening of the cortex proximal and distal to the defect and a sclerotic band of increased density that represented the slow path of erosion of the ring through the phalanx (Fig. 1C).

CASE II. (Courtesy of Dr. Alfred L. Weiner, Cincinnati.) This patient felt a painful swelling under the nail of his right index finger. The roentgenogram showed a smooth defect in the ungual tuft of the distal phalanx with a thin sclerotic margin (Fig. 2, A and B). The lesion was removed surgically. The histologic diagnosis was subungual wart.

### DISCUSSION

Case I is a unique example of foreign body migration. The diagnosis before re-

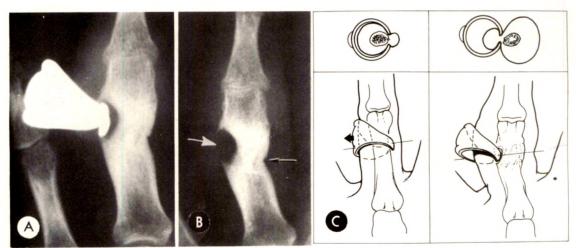


Fig. 1. Case 1. (A) The ring is embedded on the ulnar side of the proximal phalanx, the margins of its open end traversing a defect in the bone. (B) After removal of the ring, the bone defect (white arrow) is better seen. Its border is sharp and sclerotic, the edges overhanging. There is a smaller defect on the opposite side (black arrow). There is angulation of the phalanx at the site of the lesion. (C) Diagram illustrating how the bone lesion developed.

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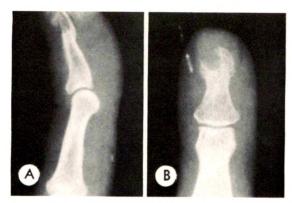


Fig. 2. Case II. (A and B) Subungual wart. Note the sharply marginated defect at the tip of the terminal phalanx. A thin sclerotic line is seen at its proximal edge. The lateral film (retouched) shows the dorsal position of the lesion. (Courtesy of Dr. Alfred L. Weiner, Cincinnati.)

moval of the ring was, of course, obvious. Case II is the only one of its kind that we have seen. The wart or verruca vulgaris is a superficial skin lesion that usually enlarges externally. The subungual position of the wart in this patient prevented surface spread, and erosion of the bone occurred. Clinical findings and biopsy are essential for diagnosis.

Roentgenographically, lesions that have to be considered in the differential diagnosis of Case II are those with a soft tissue and a bone component. These include: giant cell tumor of tendon sheath; epidermoid inclusion cyst; keratoacanthoma; glomus tumor; metastatic carcinoma; subungual squamous cell carcinoma; and melanoma.

Epidermoid inclusion cyst is a slowly expanding lesion seen in the distal phalanx, usually on the volar side.<sup>2</sup> The lesion is circular, the margins sharp and sclerotic. The bone appears expanded from within. There is a tender soft-tissue swelling adjacent to the bone defect. Trauma with a needle or splinter penetrating deep into the digit is often the cause of the displaced epidermal tissue. There is a latent period of months or years between the time of trauma and clinical evidence of the lesion.

Glomus tumor is manifest as a painful

subcutaneous digital pulsating mass, occurring most commonly during the second, third, or fourth decade. A bone defect may arise in the tip of a digit or beneath a nail. The typical appearance is a smooth concave deformity, sometimes punched out, on the dorsum or side of the tuft. Roentgenographically, the bone erosion is indistinguishable from that seen in subungual wart.

Keratoacanthoma is a benign tumor, although it grows rapidly.3 It begins as a small red papule in the skin and within 6-8 weeks grows rapidly to a smooth, firm, rounded tumor covered by a tense shiny epidermis, normal or pink in color, usually  $\frac{1}{2}$  to 3 cm. in diameter. After a period of 2-8 weeks, the lesion regresses by extrusion of its content. It occurs most frequently between 40 and 65 years of age. In rare instances, it is found subungually, manifest by pain, swelling, and erythema. Erosion of the bone is caused by pressure and not by infiltration. The lesion cannot be distinguished roentgenographically from glomus tumor or subungual wart.

Giant cell tumor of tendon sheath (villonodular synovitis, xanthoma) may cause a bone erosion, usually on the shaft of a proximal or middle phalanx. The cortex appears gouged out. Malignant neoplasm, such as a metastatic or a subungual squamous cell carcinoma or melanoma, is more destructive and less sharply defined than the subungual wart.

### SUMMARY

Two unusual causes of bone defect in the finger are described.

In one patient, erosion of the proximal phalanx was caused by a ring that eroded its way through the soft tissue and bone after an injury. In the other, a subungual wart caused a defect on the distal phalanx.

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### DISSECTING SYNOVIAL CYST OF THE POPLITEAL SPACE IN GOUT\*

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THE presence of a synovial cyst in the popliteal area (Baker's cyst) with rupture or dissection into the calf occurs primarily in rheumatoid arthritis and is unusual in other diseases.<sup>5–8</sup> Rupture or dissection of a synovial cyst may mimic deep vein thrombophlebitis, making the differentiation between the 2 therapeutically important.

We would like to report an unusual case of gout presenting as a dissecting synovial cyst mimicking deep vein thrombophlebitis.

#### REPORT OF A CASE

R.J., a 59 year old Black female, was referred to the University of Virginia Hospital with a diagnosis of deep vein thrombophlebitis in the left leg of I week's duration. Pain and swelling were first noted in the left knee I week prior to admission and then progressively involved the calf over the next 6 days. Significant past history included an 8 year history of episodic joint swelling involving, at various times, both first metatarsophalangeal ankle, knee and elbow joints.

Physical examination revealed an obese female in obvious discomfort. Her temperature was 38.5° C. Examination of the left leg revealed a large effusion in the knee, a tense, warm, tender calf approximately 5.5 cm. larger than the right, ankle edema and a positive Homan's sign. The remainder of the musculoskeletal examination was normal.

Laboratory studies revealed white blood cell count of 19,800 per cu. mm.; normal differential; sedimentation rate 86 mm./hr.; rheumatoid factor negative; uric acid 5.1 mg. per cent and repeat 7.8 mg. per cent (normal 2.4-7.8 mg. per cent). An arthrocentesis of the left knee revealed cloudy yellow fluid with many intracellular and extracellular negative birefringent needle-shaped crystals compatible with sodium urate. Roentgen examination of the left knee showed marked degenerative joint

disease. An arthrogram was obtained on the left knee, using 10 cc. of Renografin 60. The study confirmed the presence of a large synovial cyst in the popliteal area with dissection into the calf (Fig. 1).

Treatment of the dissecting synovial cyst with an intra-articular injection of 1 cc. of triamcinolone hexacetonide (Aristospan 20 mg./cc.) and treatment of the acute gout with indomethacin resulted in clinical improvement of the left leg in 24 hours.

One week later the patient returned for follow-up. She was clinically asymptomatic and physical examination of the left knee and calf was entirely normal.

#### DISCUSSION

Synovial (Baker's) cysts are fluid filled cysts located in the popliteal space. They arise most often from an enlarged popliteal bursa, usually the gastrocnemius-semimembranous bursa which communicates with the knee joint in 50-65 per cent of cases.1,2 Other synovial cysts may arise from posterior herniation of the joint capsule in response to increased intra-articular pressure. In about half of all cases there is evidence of some abnormality in the knee joint, with degenerative joint disease and rheumatoid arthritis most commonly present.3 If these synovial cysts dissect or rupture into the calf, they may result in an inflammatory reaction that may be confused with deep vein thrombophlebitis.

Dissecting synovial cysts occur primarily in rheumatoid arthritis and are uncommon in other diseases. 5-8 Solomon and Berman in 1972 reported 2 cases of gout associated with a synovial cyst of the calf. Schmidt *et al.* in 1974 made reference in their discussion to having observed dissection or rupture of synovial cysts in gout. Our patient presented with the clinical picture of deep vein thrombophlebitis.

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Fig. 1. Arthrogram (lateral view) of the left knee showing dissection of the synovial cyst into the calf.

However, the history of swelling in the left knee which extended into the calf and the finding of effusion in the knee on physical examination led to the suspicion of a dissecting synovial cyst which was confirmed by an arthrogram. It is becoming increasingly evident that dissecting synovial cysts are not pathognomonic for rheumatoid arthritis, and that gout is one more etiology to consider.

When a patient with knee involvement of any cause develops signs and symptoms of deep vein thrombophlebitis, the diagnosis of a dissecting or ruptured synovial cyst should be considered. Accurate diagnosis is clinically important. Therapy for a dissecting synovial cyst is directed toward the arthritis in general and the cyst in particular.<sup>7</sup>

We have utilized arthrography for an immediate differentiation between thrombophlebitis and dissecting synovial cyst, often on an emergency basis. Joint scanning, after intra-articular injection of iodinated I<sup>131</sup> serum albumin, has also been

utilized for this purpose<sup>6</sup> but offers no advantage over arthrography, in that injection of the joint is still required and delayed scanning as long as 24 hours later may be necessary. Delay in attainment of the diagnosis is a distinct disadvantage.

A more promising technique is that of ultrasound B-scanning.<sup>4</sup> This technique has the advantage of the avoidance of injection of the joint, is painless, and does not depend on the cyst communicating with the knee joint, as does arthrography or isotopic scanning. The speed and simplicity of the ultrasound examination suggest that this should represent the initial differential diagnostic effort.

#### SUMMARY

A case of gout associated with a dissecting synovial cyst of the popliteal space mimicking deep vein thrombophlebitis is reported.

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## ABNORMAL EPIPHYSES IN THE SICKLING DISORDERS\*

By MICHAEL C. HILL, M.B., KOOK SANG OH, M.D., JACK W. BOWERMAN, M.D., STANLEY S. SIEGELMAN, M.D., and A. EVERETTE JAMES, Jr., Sc.M., M.D., BALTIMORE, MARYLAND

HERRICK (1910) was the first to describe the abnormal erythrocytes in sickle cell anemia, which he postulated was caused by an intrinsic defect in the red blood cell. This was confirmed by Pauling (1948), who demonstrated the abnormality in the hemoglobin molecule.

Many authors have described the bone abnormalities in the sickling disorders. <sup>3,4-6,8,12,18,19,21</sup> Much attention has been directed to the abnormalities in the femoral capital epiphyses, <sup>7,13,17,20,22</sup> but little attention has been paid to abnormalities in other epiphyses.

The purpose of our study was to determine the incidence, distribution and type of epiphyseal changes found in the sickling disorders.

#### MATERIAL AND METHOD

We reviewed the roentgenograms of 400 patients discharged from the Johns Hopkins Hospital between January 1968 and July 1971 with a diagnosis of one of the sickling disorders. Unequivocal epiphyseal abnormalities were found in 37 patients. The medical records of these patients were carefully reviewed to determine whether the epiphyseal abnormalities could have been caused by some other agent. Eleven of these 37 patients were excluded from the study because of insufficient clinical information or because the epiphyseal abnormalities could well have been caused by infection, systemic steroid therapy, or diseases associated with epiphyseal infarcts such as systemic lupus erythematosus. In the remaining 26 patients (6.5 per cent) the epiphyseal abnormalities most likely represented bone infarcts.

#### RESULTS

Table I lists the number and the mean age of the patients with each type of sickling disorder. All patients were Black, and 3I per cent were younger than 17 years. The 56 per cent of patients with sickle cell anemia tended to be the youngest patients, while the 3I per cent with sickle cell trait tended to be the oldest. Nine per cent had sickle C disease, while sickle thalassemia, sickle F, and hemoglobin AC comprised slightly less than 4 per cent of the group.

Of the 26 patients selected as having epiphyseal infarcts caused by a sickling disorder, 12 were male and 14 were female (Table II). All except 3 (Patients 2, 10, and 15) attended the Johns Hopkins Hospital Sickle Cell Disease Clinic, where hemoglobin electrophoresis was performed. The mean follow-up period of all patients was 5.3 years. Three of the 26 patients were seen only once (Patients 1, 2, and 9), while 2 were followed for 13 years (Patients 7 and 12). The types of sickling disorders and

Table I

NUMBER OF PATIENTS WITH EACH SICKLING
DISORDER AND THE MEAN AGE

Type of Sickling Disorder	No. of Patients	Mean Age in Years	
Sickle cell anemia	225 (56%)	19	
Sickle cell trait	124 (31%)	37	
Sickle C disease	35 (9%)	26	
Sickle thalassemia	13 (3%)	28	
Sickle F	2 (0.5%)	25	
Hemoglobin AC	1 (0.25%)	73	
Total	400	35	

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TABLE II
SUMMARY OF PATIENTS

Patient	Age in Years as of Last	Sex	Hb Electro-		Roentgenographic Changes		
No.	Roentgenogram	Sex	phoresis		Proximal Humeral Epiphysis	Femoral Capital Epiphysis	Other
Ι.	29	M	S.S.	none	(B) S. and L.	(B) S. and L.	
2.	14	F	S.S.	none	(R) S. and L. with mild cor- tical irregularity		
3.	29	F	S.S.	7 yr.	(B) S.	(B) S. and L.	Patchy sclerosis (L.) proxi- mal tibial epiphysis
4.	30	F	S.C.	2 yr.	(B) S. and L.		
5.	54	M	S-Thal	2½ yr.	(R) S.	(B) S. and L.	
6.	33	F	S.S.	8 yr.	(B) S, and L.	(B) S.	
7.	28	M	S.S.	13 yr.		<ul><li>(R) aseptic necrosis; treated with total hip replacement</li></ul>	
8.	12	F	S.S.	8 yr.			Aseptic necrosis proximal (L radial epiphysis
Q.	26	F	S.C.	none	(B) S. and L.	(B) S, and L.	
10.	38	F	S.S.	3 yr.	(B) S. and L.	(B) S. and L.	(B) S. and L. in distal femora epiphysis
II.	52	F	S.S.	12 yr.	(B) S, and L, unchanged over	(B) S. and L. unchanged over 8 years	
12.	22	F	S.S.	13 yr.	(L) S.	(R) S. and L.	
13.	33	M	S.C.	ı yr.		(B) S. and L. with flattening of both heads	
14.	21	F	S.S.	12 yr.	(B) S, and L, with mild cor- tical irregularity	(L) S. and L.	
15.	37	M	S.A.	2 yr.	(B) S, and L, unchanged over 2 years	(B) S. and L. unchanged over 2 years	
16,	21	M	S.S.	11 yr.		(B) S, and L.	
17.	40	M	S.S.	8 yr.		(L) S. (R) S. and L. and corti- cal irregularity	(B) S. and L. in distal femo ral epiphysis with cortica fracture; (B) proximal tib ial epiphysis with S. and L
18.	23	F	S.C.	4 ут.	(B) S. unchanged over 4 years	(R) aseptic necrosis; treated with a girdlestone proce- dure; (L) with S. and L. and mild cortical irregu- larity	
19.	26	M	S.C.	5 yr.	(L) S. and L.		
20.	18	M	S.S.	2 yr.	(B) S, and L. unchanged over 2 years		
21.	11	F	S.S.	3 yr.	(B) S. and L.		
22.	30	M	S.S.	ı yr.	(B) S. unchanged over 1 year	porosis	
23.	20	M	S.S.	7 yr.	(R) S, and L, unchanged over 5 years. (L) S, and L, with cortical fracture	(B) S. and L. unchanged over 6 years	(B) distal femoral epiphysi with S.
24.	24	F	S.S.	7 yr.	(B) S, and L, unchanged over 5 years	(R) aseptic necrosis. (L) with S.	
25.	7	M	S.C.	3 ут.	(B) aseptic necrosis	(B) S. and L. with cortical ir- regularity	
26.	23	F	S S.	5 yr.	(L) S. and L. with cortical fracture	- ·	

All patients had other osseous manifestations of the sickling disorders except Patient 15. (R) = right; (L) = left; (B) = bilateral; S. = sclerosis; L. = lucency.

ages are given in Table III. While epiphyseal infarcts occurred most commonly with sickle cell anemia, the frequency was approximately twice as high in sickle C disease (17 per cent) as in sickle cell anemia (8 per cent). Epiphyseal changes are uncommon in patients with sickle cell trait (0.8 per cent). At the time they had their latest roentgenogram the mean age of the patients with sickle cell anemia and sickle C disease was almost the same. Patients with sickle cell trait and sickle thalassemia tended to be older.

Table Iv gives the distribution of epiphyseal infarcts. The epiphyses most commonly involved were the proximal humeral and capital femoral epiphyses; in 15 patients both were involved. Involvement of these epiphyses was usually bilateral. The distal femoral epiphyses, proximal tibial epiphyses, distal tibial epiphyses, and the left proximal radial epiphyses were less commonly involved. All patients also had other osseous changes of the sickling disorders except Patient 15, who had sickle cell trait.

TABLE III

PATIENTS WITH EPIPHYSEAL ABNORMALITIES
AND THEIR AGE

Туре	No. of Cases	Incidence	Mean Age	
Sickle cell trait	I	0.8%	37 yr.	
Sickle cell anemia	18	8.0%	26 yr.	
Sickle C disease	6	17.1%	24 yr.	
Sickle thalassemia	I	7.7%	54 yr.	

Four roentgenographic patterns of epiphyseal infarcts were found: (1) diffuse sclerosis; (2) patchy or focal sclerosis (Fig. 1), usually with radiolucencies of various sizes (Fig. 2; 3; and 5). Focal areas of sclerosis may not be detected if the involved portion is overlapped by the acetabulum at the hip, or by the acromion, or glenoid fossa at the shoulder; (3) large, single radiolucency, simulating chondroblastomas (Fig. 5)<sup>11</sup>; (4) cortical fractures, usually with partial or total bone collapse (Fig. 8; 9; 11; and 14).

The most common finding was a combination of sclerotic and lucent changes (Fig. 2; and 3). Once they appear most of these infracts remain unchanged for years (Patient 11). Healing, however, occurred in some patients. Patient 21 developed, during a 1 year period, sclerotic and lucent changes in both proximal humeral epiphyses that disappeared in the following year (Fig. 4; 5; and 6).

Cortical destruction occurred in the capital femoral epiphyses in 6 patients (Patients 7; 13; 17; 18; 24; and 25) (Fig.

. Table IV

DISTRIBUTION OF EPIPHYSEAL INFARCTS IN 26 CASES

Epiphysis	Bilateral	Right	Left	Total
Proximal humeral	18	I	2	21
Capital femoral	16	3	I	20
Distal femoral	3	0	0	3
Proximal tibial	I	0	I	2
Distal tibial	I	0	0	I
Proximal radial	0	0	I	I

8; and 9), in the proximal humeral epiphyses in 5 patients (Patients 2; 14; 23; 25; and 26), in the distal femoral epiphyses of Patient 17 (Fig. 11), and the left proximal radial epiphyses of Patient 8. Patients 7 and 18 required surgery for destruction of the femoral capital epiphyses. Patient 7 had a total replacement of the right hip (Fig. 10). Pathologic examination of the right femoral head showed the changes of aseptic necrosis. Patients 14 and 23 had healing of their cortical fractures in the proximal humeral epiphyses over intervals of 8 and 6 years, respectively. After 8 years the proximal humeral epiphyses apparently had returned to normal in Patient 14 (Fig. 12; and 13), but after 6 years Patient 23 still had residual sclerotic and radiolucent changes. Patient 8 had infarction of the

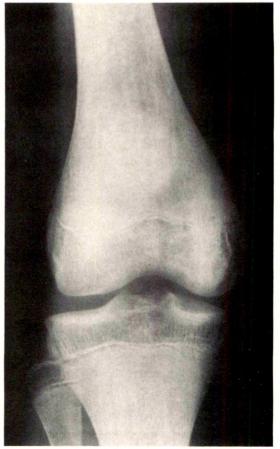


Fig. 1. Patient 23. Patchy sclerosis in the right distal femoral epiphysis.

proximal epiphyses of the left radius. The epiphyses first became irregular in outline and then fragmented. At that time the patient had surgery as infection was suspected; no pus was found and cultures were negative. The epiphyses healed over a period of I year and fused prematurely.

Correlation of the epiphyseal changes with the clinical symptoms and signs recorded in the chart was not feasible as most patients had multiple sickle cell crises with generalized bone pain and roentgenograms had not been obtained unless the patient had severe localizing signs. Roentgenograms may be normal early in the course of epiphyseal infarcts even though the patients have symptoms. 17,18 When Patient 7 first had pain in his right hip, the roentgenogram was normal (Fig. 7), but a bone marrow scan with technetium 99m sulfur colloid showed decreased uptake (Fig. 15).



Fig. 2. Patient 17. Sclerotic and lucent changes in the right femoral capital epiphysis.



Fig. 3. Patient 17. Increased sclerosis with lucencies of the right femoral capital epiphysis taken 6 years after the roentgenogram of Figure 2.

He subsequently developed aseptic necrosis of the right femoral head (Fig. 8; and 9) and required total hip replacement 7 months later (Fig. 10). The patients with localizing symptoms generally had marked radiolucent and sclerotic changes in the epiphyses that frequently were accompanied by cortical fracture and collapse.

#### DISCUSSION

In the sickling disorders the abnormality occurs in the amino acid sequence of the beta polypeptide chain of the hemoglobin molecule.<sup>7,8</sup> With deoxygenation, the abnormal hemoglobin forms a tactoid which is attributed to interlocking of the alpha chain with the abnormal beta chain. Tactoid formation distorts the shape of the red blood cell, producing the characteristic sickle-like shape.



Fig. 4. Patient 21. Normal proximal humeral epiphysis.

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The etiology of bone infarcts in the sickling disorders is unknown. The most frequently advanced theory is that hypoxia causes red blood cells to sickle. This leads to red blood cell sludging and vascular stasis that may cause thrombosis and infarction.15 Sherman,22 however, was not able to demonstrate vascular thrombosis in patients with aseptic necrosis of the femoral head secondary to the sickling disorders. She postulated that the infarct may be caused by local damage to very small vessels. Anoxia causes focal endothelial destruction which is followed by disruption of the vessel wall and interstitial hemorrhage. She showed that focal sub-



Fig. 5. Patient 21. Single, large lucency in the proximal right humeral epiphysis. This has appeared since the previous roentgenogram (Fig. 4) taken 18 months previously.



Fig. 6. Patient 21. Normal right proximal humeral epiphysis taken 1 year after the roentgenogram in Figure 5.

chondral hemorrhage may separate the articular cartilage from the underlying bone, while bleeding into the joint with chronic synovitis and pannus formation destroys the cartilage from above.

Bone infarcts have no roentgenographic changes unless the infarct is revascularized, since the mineral content and architecture of the infarcted trabeculae remain unchanged.<sup>19</sup> With revascularization of the infarct, granulation tissue grows into the necrotic area. Reossification is accompanied by the deposition of new bone on the framework of the dead trabeculae giving the roentgenographic appearance of sclerosis. Some of the dead trabeculae are reabsorbed, however, a process than can require years and may never be complete.9 When absorption of dead trabeculae proceeds faster than reossification, the infarct appears as a radiolucency on the roentgenogram. Epiphyseal infarcts due to the sickling disorders are indistinguishable from those due to other causes.<sup>17</sup>

Bone infarcts are most common in ado-



Fig. 7. Patient 7. Normal right hip.



Fig. 8. Patient 7. Sclerosis, lucency and cortical fractures appearing since the roentgenogram of Figure 7 taken 5 months previously.

lescents and young adults; 6,8,18 16 of our patients were between the ages of 15 and 30 years. Only 4 were younger than 15 years and the youngest patient was 7 years. In infants and children the osseous lesions of sickle cell disease involve the small bones of the hands and feet<sup>2,14</sup> and the shafts of the long bones. 4,6,12 Epiphyseal changes are uncommon in this age group, possibly because the blood supply to the epiphyses is best during growth.

The blood supply to long bones<sup>27</sup> and to the femoral capital epiphyses both during growth<sup>26</sup> and in the adult<sup>25</sup> have been well described by Trueta. At birth the femoral capital epiphysis is supplied by epiphyseal vessels, by vessels from the shaft and sometimes by vessels from the ligamentum teres. The latter 2 regress so that between the age of 4 and 10 years the vascular supply is predominantly from the lateral epiphy-



Fig. 9. Patient 7. Sclerotic and lucent changes with increased cortical destruction since the roentgenogram of Figure 8 taken 2 months previously.

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seal vessels. The medial epiphyseal vessels from the ligamentum teres appear after the age of 10 years. When the growth plate closes, the epiphyseal vessels anastomose with the metaphyseal vessels. Trueta<sup>26</sup> states that during growth the epiphyseal and the metaphyseal vessels are separated by the growth plate and do not anastomose. Spira and Farin<sup>23</sup> and Tilling,<sup>24</sup> however, have demonstrated epiphyseal vessels that traverse the growth plate and anastomose with the metaphyseal vessels.

On reviewing the epiphyseal blood supply, we can see no definite reason why epiphyseal infarcts are uncommon in children. Sherman<sup>22</sup> postulated that the femoral capital epiphysis of the young child is small and surrounded by a thick layer of cartilage which is capable of sustaining



Fig. 10. Patient 7. Roentgenogram taken following total hip replacement on the right.

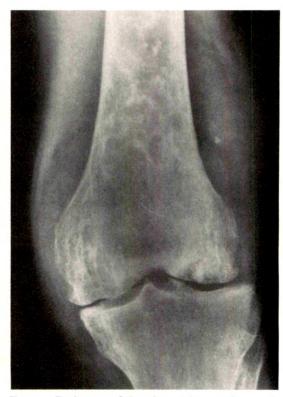


Fig. 11. Patient 17. Sclerotic and lucent changes in the distal femoral epiphysis with cortical fracture.

itself on synovial fluid and of mantainingi its shape, whatever the state of the tissues beneath. This may protect the epiphyses from deformity following infarction in the young child.

Most of the osseous changes in the sickling disorders have been well described. 8,10,12,18 Bone infarcts are well known. 6,14,16 Particular attention has been given to diaphyseal infarcts 4,5 and to necrosis of the femoral head. 7,13,17,20,22 Although infarcts of other epiphyses are mentioned, 3,6,9,12,18,19,21 we are not aware of a review of a large series of patients with special attention to epiphyseal infarcts.

Epiphyseal infarcts in the sickling disorders are most common with sickle cell anemia (56 per cent). However, the frequency was approximately twice as high in sickle C disease (17 per cent) as in sickle cell anemia (8 per cent). 3,7,9,16,21 Epiphyseal infarcts are uncommon in sickle cell trait 19,20 and sickle thalassemia. When they do occur it is at a later age. The epiphyses most commonly involved are the proximal humeral and capital femoral



Fig. 13. Patient 14. Normal right proximal humeral epiphysis taken 8 years after the roentgenogram of Figure 12.

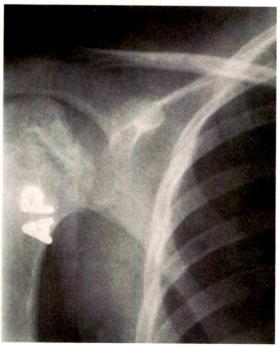


Fig. 12. Patient 14. Sclerosis, lucency, and irregularity of the medial portion of the right proximal humeral epiphysis.



Fig. 14. Patient 26. Sclerotic and lucent changes in the left proximal humeral epiphysis with cortical fracture and partial collapse.

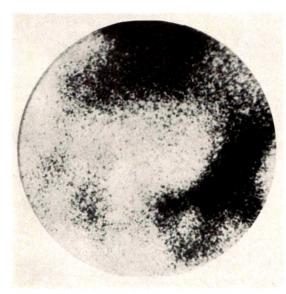


Fig. 15. Patient 7. Bone marrow scan using technetium 99m sulfur colloid showing decreased uptake in the area of the right hip. This scan was obtained at the same time as the roentgenogram of Figure 7.

epiphyses. In our group of patients the number of epiphyseal infarcts involving the proximal humeral and capital femoral epiphyses was almost equal and both usually occurred in the same patient. In most patients the epiphyseal involvement was bilateral. This partly agrees with Chung and Ralston,7 who reviewed aseptic necrosis of the femoral head in sickle cell disease; however, of their 13 cases only 6 had infarcts of the humeral head. Collapse of the femoral head is more common than collapse of the humeral head and is less likely to heal with restoration of the normal outline of the head; presumably this difference relates to weight bearing function of the hip joint.

#### CONCLUSION

As treatment of the sickling disorders improves, the patients presumably will live longer and have a greater opportunity to develop epiphyseal infarcts. Consequently, infarcts and their sequelae may be expected to represent an increasingly important source of debility in the sickling disorders.

Early diagnosis of epiphyseal infarction and prompt institution of adequate treatment possibly would decrease the frequency of secondary collapse with resulting functional disability.

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# ROENTGENOGRAPHIC ANATOMY OF THE TENDON SHEATHS OF THE HAND AND WRIST: TENOGRAPHY\*

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THE radiographic evaluation of the normal and abnormal tendon sheaths of the hand and wrist has received little attention. 12 These synovial-lined structures are altered in various disease states, becoming local avenues for the spread of infection from one site to another 5 or partaking in a more widespread synovial affliction such as rheumatoid arthritis. 2

It is the purpose of this report to outline the anatomy of the tendon sheaths of the hand and wrist emphasizing relationships which are of importance in the pathogenesis of certain disorders, and to describe tenography, the technique of contrast evaluation to these structures.

#### MATERIAL

Hands and wrists in 10 cadavers were utilized. They were first injected at various sites, as described below. Subsequent evaluation included either careful dissection of the tendons on the volar and dorsal surfaces of the hand and wrist or freezing for 48 hours at  $-20^{\circ}$  C., followed by sectioning in various planes.

#### METHOD OF TENOGRAPHY

In all 10 instances evaluation of the flexor tendon sheaths in each finger was accomplished by the introduction of .5-3 ml, of Renografin 60 (meglumine diatrizoate, Squibb); the exact amount depended upon whether or not the individual tendon sheath communicated with the radial or ulnar bursa in the wrist (Table 1). A 22 gauge, 1½ inch needle is introduced through the palmar skin overlying the distal onethird of the proximal phalanx of the second through fifth fingers. As one advances the needle in a proximal direction, palpating the tendon, one notes the increased resistance as the needle enters the tendon. One can withdraw the needle slightly, noting the sudden drop in resistance, and further advance it in a shallow attitude within the sheath.

The injection of the sheath of the flexor pollicis longus may be accomplished by flexing the terminal phalanx of the thumb, palpating the tendon, and inserting the needle directly into it.

In 3 instances contrast evaluation of the

• City of Industry	Number of	Communications		
Site of Injection	Injections	Ulnar Bursa	Radial Bursa	
Thumb	IO		IO	
Index Finger	10			
Middle Finger	10	-		
Ring Finger	10		*******	
Little Finger	10	5	Brighton	

<sup>\*</sup> From the Departments of Radiology, University Hospital, University of California at San Diego and the Veterans Administration Hospital, San Diego, California.